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# JOURNAL

OF THE

# FRANKLIN INSTITUTE

OF THE

State of Pennsylvania

AND

# MECHANICS' REGISTER.

DEVOTED TO

MECHANICAL AND PHYSICAL SCIENCE,

**CIVIL ENGINEERING, THE ARTS AND MANUFACTURES,**

AND THE RECORDING OF

AMERICAN AND OTHER PATENTED INVENTIONS.

EDITED

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JANUARY, 1838.

## Practical and Theoretical Mechanics and Chemistry.

### *On Hydraulic and Common Mortars. By General* Treussart, *Inspecteur du Genie. Translated from the French by J. G. Totten, Lt. Col. of Eng. and Brevet Col. United States Army.*

(Continued from Vol. XX, p. 399.)

### Art. VII. *Of Artificial Trass and Puzzalona.*

Mr. Baggé, a Swedish Engineer, was, I think, the first who attempted to make artificial puzzalona. This Engineer used, in his experiments, a species of black, and quite hard, schistus; he heated it highly several times; afterwards reduced it to powder, and having mixed it with lime, announced having obtained an excellent mortar, having all the properties of mortar made of puzzalona.

I do not at all doubt the success of Mr. Baggé: but his experiments having been repeated elsewhere, a less satisfactory result was secured. This was owing to using schists of a different composition, and which, in lieu of being heated highly, like those of the Swedish Engineer, required to be heated moderately.

Mr. Faujas de Saint-Fond made several researches in 1778 with the puzzalonas of Vivarais, which he found to be equal to the puzzalonas of Italy. He showed, also, that the trass of Andernach was a true puzzalona.

In 1786 Mr. Chaptal repeated the experiments of Mr. Faujas de Saint-

Fond, on the puzzalonas of Vivarais, and found that they were inferior to those of Italy. This contradiction between the results obtained by Mr. Faujas de Saint-Fond and Mr. Chaptal is easily explained, for one used hydraulic lime in his experiments, and the other used fat lime.

Mr. Chaptal published in 1787 a memoir on the use of the ochreous earths of the south of France. These earths were calcined in a kiln like those used in some countries for burning lime. The kilns are reversed cones from about eight feet eight inches to about ten feet ten inches in height, and are from six to eight feet in diameter at the base: an opening is left near the apex of the cone, through which to withdraw the products of calcination: these kilns are filled by placing alternately, a layer of sea-coal or turf, and a layer of the ochreous earth; the fire is kindled, after a few layers have been placed, and, when it is in full action, other alternate layers are added until the kiln is full. When the lower portion, which was the first heated, is sufficiently calcined, it is withdrawn as fast as necessary, and other new layers of clay and fuel are successively added above. Thus the burning is continual; the clays heat gently near the top of the kiln, and are subject to a much greater heat in the middle: they gradually cool towards the bottom, by the action of the current of air, after the fuel is consumed. This manner of burning earths, possesses great advantages as I shall have occasion to show. It would be equally advantageous to calcine hydraulic limes in these kilns, because, as we have seen above, it is very important to use these limes soon after they are burned. By constructing several kilns of this kind, there might be as great a supply of fresh lime as could be needed.

Mr. Chaptal attributed to iron, a great effect in improving puzzalonas; and he appears to have attributed a very feeble one to alumine. Mr. Vicat says, on this subject, in his memoir: "If, as Mr. Chaptal assures us, clays deprived of iron, and calcined, cannot be employed as puzzalonas, it must be the oxide of iron that acts principally on the silex and modifies it, by the aid of fire in the ochreous earths, as the lime does in the hydraulic limestones: the alumine, therefore, appears to take the least part in these reactions; it does, nevertheless, make part of good puzzalonas."

Experiments which follow will show that iron plays no part in the preparation of puzzalonas, while alumine is very active. We shall see. also, that there is another substance which is very active and which has occasioned the divergencies of opinion on the preparation of puzzalona; but I will not anticipate; and will go on with the statement of the various attempts made to produce factitious puzzalona.

From experiments made at Cherbourg in 1787 by Mr. de Cessart, it appeared that basalts, obtained in the Department of the *Haute-Loire*, and pulverized after having been calcined, produced a mortar possessing all the qualities of those made with Italian puzzalona. Analysis shows this basalt to contain in one hundred parts, the following; Alumine, 16.75; Silex, 44.50; Oxide of iron, 20.00; Lime, 9.50; oxide of Manganese, 2.37; Soda, 2.60; Water, 2.00; loss, 2.28.

The works in the port of Cherbourg required a great quantity of puzzalona; but the war which broke out with England on the rupture of the treaty of Amiens, raised the substance to an exorbitant price: it was calculated that the price of a cubic metre (35.34 cubic feet) cost, in 1803, more than 400 francs (about $76.00.)

They might easily have procured on the spot, clays which would have given results absolutely the same as those afforded by Italian puzzalona, at the cost of about 30 francs (about $6.00.) And had they understood the manner of making puzzalona, there would have been a great saving. Considerations of this sort induced Mr. Gratien, Senior, Engineer of roads and bridges, to occupy himself with the subject. He made a few essays with the porcelain clay of Valognes, and made many with the schists of Haineville, which he calcined, in repetition of the experiments of the Swedish engineer. The Valognes clay calcined, gave but feeble results; the Haineville schists gave better; analysis showed this schist to consist, in 100 parts, of the following: alumine, 26.00; silex, 46.00; magnesia, 8.00; lime, 4.00; oxide of iron, 14.00; loss and water, 2.00. The results of the experiments of Mr. Gratien, Senior, are given in two memoirs which he published, one in 1805, the other 1807. A commission of the Institute was charged with examining experiments, comparative of mortars made of puzzalona, of trass, and of the Cherbourg schist; the judgment of this commission is inserted by Mr. Gratien in his memoir of 1807, page 9; it declares "that after taking from the water the twelve boxes of beton of different compositions:

" 1st. All had acquired a certain consistence, but very different amongst themselves.

"2nd. The difference was striking between the betons composed of puzzalona and trass, and those into which these substances did not enter.

" 3rd. The two compositions of burnt and pulverized schistus offered a resistance quite satisfactory, but not so great as it probably would be after a longer immersion.

The above report shows that Mr. Gratien obtained with the schists, results inferior to those given by puzzalona.

In 1806 Mr. Le Masson, Engineer of roads and bridges, at Rouen, attempted, in concert with Mr. Vitalis, to make factitious puzzalona by calcining yellow ochreous earths, according to the process of Mr. Chaptal. The betons made with the calcined earth, having acquired a remarkable consistence, Mr. Le Masson, in 1807, repeated the experiments on a larger scale: he immersed, in the Seine, casks filled with beton made of the calcined ochreous earth. After six months, the casks were taken out, and it was found that the betons had acquired such hardness that it was necessary to strike it two hundred times with a mass of iron weighing $26\frac{4}{10}$ lbs. to break in a depth of ten to twelve inches; the tenacity was so great, that the entire mass weighing 2800 lbs. was suspended by means of a *tire fond* (lewis?) Mr. Gratien and Mr. Vitalis judged that the masonry had acquired a hardness greater than could ever be absolutely necessary, even in constructions that require the greatest solidity in their foundations. These experiments are reported in the memoir of Mr. Gratien 1807—page 46 and following.

Mr. Vicat in his memoir of 1818 confined himself to reporting the different attempts that had been made, up to that time, to form artificial puzzalona: but in 1819 he sent to the Institute a memoir on that subject. I do not know whether this memoir was printed, but an extract is contained in the *annales de chimie et de physique* of 1820, Vol. XV, page 365 and following. After several observations on limestone, on the action of fire on calcareous stones, and the combination of water with lime, the author gives a succinct history of puzzalona. We find afterward the following passage.

"Since the quality of natural hydraulic lime, depends solely on the presence of a certain quantity of clay, combined by fire with the calcareous matter, it was natural to think that by mixing clay in suitable proportions with fat lime, slaked, no matter how, and then submitting the mixture to calcination, a similar result would be obtained: experiments made on a large scale, and in many places, have confirmed this idea in a manner so complete, that it is now possible to fabricate any where, and at a very moderate price, artificial lime superior to the natural analagous lime."

"In like manner, since chemical analysis gave, for the constituents of natural puzzalona, silex, alumine, oxide of iron, and a little lime; it was easy to suppose that our clays, of which the composition is altogether similar, might be transformed, by burning, into artificial puzzalonas. This idea was already old at the period of the experiments of the author of these researches; but by a remarkable fatality it was as if stricken with sterility: the circumstances on which the quantities of good puzzalona depend, had not been determined with sufficient precision. There was a persuasion, for example, that iron was very active therein; that, therefore, only ochreous clays should be used; that in order to a more perfect imitation of nature, there should be a high degree of heat, 'because,' said they, 'the fire of volcanos is much more intense than the fire of our kilns.' (Several geologists are of a contrary opinion.) Certain puzzalonas, came, beyond doubt, in the form of lava, from volcanos: they were in fact subject to a high degree of heat; but since the very distant epoch of their formation, they have sustained diverse decompositions, either from intestine modifications or from the action of acid vapours, or from other causes, and these decompositions have totally changed the mode of combination of their principles. As to the red puzzalonas of the neighbourhood of Rome, every thing shows that they were only vast beds of ochreous clay variously burned, either by subterranean fires, or by currents of lava which covered them and broke them up in every direction. Thus their quality is very variable according to the disposition and depth of the beds. But whatever may be the process of the formation of these substances, it is demonstrated that all the mystery of their properties, resides, not in the presence of iron or lime, but in a particular state of combination of silex and alumine—a state to which all clays, soft and greasy to the touch, may be brought, with the greatest facility, by a light calcination. The means which hitherto appear to have succeeded best, consists in reducing the dry clay to a very fine powder, and calcining it, for some minutes, on metallic plates heated to an obscure (*brun*) red. The truth is, that practice has not yet fully matured the process, and it is probable that full success requires the contrivance of a mode of calcination more expeditious and convenient than the above: but the problem is not the less resolved."

Such is the mode proposed by Mr. Vicat for making factitious puzzalona; and he teaches us nothing new, for he does not tell us what is the particular condition in which the silex and alumine should be found to afford good results. Opinions were for a long time divided on the question whether the clays, which it was desired to convert into good cements, should be heated much or little—these cements being, really, artificial puzzalonas.* Mr. Vicat has adopted the opinion of those who thought they should be burned but little; but experiments which are to follow will show that this (as a general principle) is erroneous—it being necessary to burn more or less, according to the composition of the clay. The problem, therefore, was not resolved by Mr. Vicat, though he says it was; and the experiments which follow will show in what it really consists.

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* By the term *ciment*—translated, in the above sentence, *cement*, the French often mean, simply brick dust or tile dust; and it will be so rendered wherever it is supposed to bear that meaning.—Trans.

I made several essays, substituting brick and tile dust for trass. To this end I composed a number of mortars of fat lime and the dust of bricks or tiles taken from all the kilns of the neighbourhood. A part of the mortars were made of brick dust, and a part of tile dust. I obtained many results: —sometimes very good, sometimes indifferent, and sometimes very bad. What struck me much, at first, was, that mortars made of different dusts coming from the same burning gave very different results: notwithstanding that the dusts were of the same burning, were all made of the same clay, were used with the same lime, and that all other circumstances were the same. I saw from this, that great risk was run of making bad mortar, by taking brick or tile dusts without discrimination. I know that the great majority of constructors preferred highly burned dusts, and that, although made of the same clay, they much preferred dust of tiles to that of bricks. To settle my opinion on these two points, and to explain up contradictory results that I had obtained, I made the experiments reported in the following table.

## Table No. XVI.

| No. of the mortar. | Composition of the mortar. | | | No. of days required to harden in water. | Weight supported before breaking. |
|---|---|---|---|---|---|
| | | | | days. | lbs. |
| 1 | Fat Lime slaked to powder and measured in powder<br>Dust of bricks but little burned | 1<br>2 | 3 | 11 | 330 |
| 2 | Lime the same<br>Dust of bricks well burned | 1<br>2 | 3 | +40 | 180 |
| 3 | Lime the same<br>Dust of tiles but little burned | 1<br>2 | 3 | 5 | 275 |
| 4 | Lime the same<br>Dust of tiles well burned | 1<br>2 | 3 | +30 | 125 [*] |
| 5 | Lime the same<br>Dust of tiles same as No. 3 but which had been reburned in a reverberatory furnace for six hours. | 1<br>2 | 3 | | |

### *Observations on the experiments of Table* No. XVI.

In order to make the above five experiments, I went to the nearest brick-yard, at Strasburg; and there got bricks and tiles, both lightly burned, and well burned. It was easy to dintinguish them, for the first were very red, and but feebly sonorous, while those which were *well burned*, as it is called, were of a fawn colour (*fauve*) (pale red) and quite sonorous. The burners are never mistaken in this particular.

The first four experiments show that I obtained much better results with bricks and tiles but little burned, than with those well burned. We see, also, that the hardening was much more prompt, with the slightly burned dusts: for No. 2 required more than forty days to harden, while No. 1 required but 11 days; No. 4 took more than 30 days to indurate, while No. 3 took but 5 days. We see, also, contrary to the general opinion, that brick dust gave better results than tile dust. No. 5 was made with the same dust as No. 3, after it had been reburnt for six hours in a reverberatory furnace, keeping it constantly at a low red heat. The mortar made of this last dust took no consistence, and when I withdrew it from the water after a year, it was as soft as if it had been made of lime and sand only. This shows how important it is not to use these dusts at hazard; for they are always costly and are sometimes no better than so much sand. More than one fault of this kind has been committed in great works, as I shall have occasion to remark. The experiments of the above table agree with the opinion of Mr. Vicat, who says, that clay should be submitted to a feeble heat only. But on resorting to another tile kiln, where they used another clay in making bricks and tiles; and making therewith four new experiments exactly like the first four in the above table. I was surprised to find results directly opposite to those before obtained; that is to say, the dusts furnished by bricks and tiles but little burned, gave results much inferior to those afforded by the dusts from well burned bricks and tiles. The experiments in the following table, were made with this cement.

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[*] In my pamphlet of 1824, and in the 7th number of the *mémorial*, copied therefrom, the resistance, by a typographical error, is set down as 87 kil. (194 lbs.) Au.

Table XVII.

| No. of the mortar. | Composition of the mortar. | No. of days required to harden in water. | Weight supported before breaking. |
|---|---|---|---|
| | | days. | lbs. |
| 1 | Fat lime slaked to powder and measured in powder . . 1<br>Dust of tiles but little burned . 2 } 3 | 12 | 139 |
| 2 | Lime the same . . . 1<br>Dust of No. 1 reburnt for half an hour 2 } 3 | 12 | 176 |
| 3 | Lime the same . . . 1<br>Dust of No. 1 reburnt for one hour . 2 } 3 | 15 | 282 |
| 4 | Lime the same . . . 1<br>Dust of No. 1 reburnt for two hours . 2 } 3 | 20 | 319 |

*Observations on the experiments of Table* No. XVII.

To make the experiments of table No. XVII, I took dust from the tile kiln which had given results opposite to those in table No. XVI, dust but lightly burned, and made mortars therewith, in its then state, and also after it had been reburnt.

Mortar No. 1 contains the slightly burned dust, and Nos. 2, 3 and 4 the same dust after it had been reburnt for the periods of time expressed in the table. According as the dust was burned more and more, the resistance increased; and it is probable it would have been further augmented by further burning. It should be noticed that the induration became slower as the resistance became greater. We shall see, below, that the slowness of the hardening is due to the dusts having been heated in crucibles, where they were out of contact of the air.

We see that the dusts of table No. XVI gave me good results only when they had been but little burned, while it was the contrary with those of table No. XVII. These opposite results led me to examine the composition of the clays of these two brick yards; and I ascertained that the clay which gave the dust of table No. XVII contained very little carbonate of lime, while that which produced the dust of table No. XVI, contained almost a fifth of its weight of that substance. I repeated the experiment with the clays of several other tile kilns, and I always obtained this remarkable result, namely, when the clays contained little or no carbonate of lime, gentle burning imparted only mediocre qualities, while strong burning gave them excellent qualities. When, on the contrary, the clays contained from one to two tenths of carbonate of lime I procured good results only by heating lightly, and, if I augmented the degree of calcination the quality was impaired; and if the heat had been very great, all hydraulic property was lost. We see, consequently, that Mr. Vicat was in error in saying, as I have already quoted him at page 4, "that all the mystery of puzzalona resides, not in the presence of iron or lime, but in a particular state of combination of silex and alumine." It is certain, on the contrary, that the presence of lime in clays has a great influence on the quality of the puzzalona. At the same time we may conceive why those who had been engaged in producing this substance, were induced to announce, some, that it was necessary to heat clays but little, and others that it was necessary to heat them highly. It follows from what I have said that what was true of one kind of clay might not be true of another, although having the same aspect. We in no degree contest the point, for example, of Mr. Le Masson having obtained, at Rouen, very good results with a calcined ochreous earth; but had he submitted to the same degree of calcination an ochreous earth of the same appearance, but containing more or less lime, he would have had very different results. If two clays, equally greasy to the touch, be taken, of which one shall contain one fifth of lime, while the other contains none, and if they be equally heated, it may happen that neither of the results will possess hydraulic properties of any moment: that which contained the lime will have been too much burned, while that which was without lime will not have been burned enough. On the other hand if that containing lime be less burned and that having no lime be more burned, then very good results may be had from both.

The above experiments were made in the autumn of 1821. As they are the foundation of the fabrication of artificial puzzalonas, and as the important part that lime acts in this fabrication had not been noticed, I addressed, in 1822, to the Minister of War, a memoir containing the result of my experiments. An extract from this memoir may be found in the *Moniteur* of January 22nd, 1823.

Mr. Sganzin reports, page 31 of his *cours de construction*, that "they prepare at Amsterdam an artificial trass: it is clay taken from the bottom of the sea, which they burn highly as they do bricks. These brick-like pieces are broken by pestles worked by horses: the substance is then put under millstones, where it acquires the fineness necessary to be converted into mortar by mixture with lime.

"Bergman analysed this artificial trass, which bears the name of *privileged cement of Holland:* he found that it contained in about 100 parts Silex, from 55 to 60; Alumine, 19 to 20; Lime, 5 to 6; Iron, 15 to 20.

There is no doubt, considering the composition of this clay, and the degree of heat to which it is subjected, that it must give very good artificial trass.

I give below, in a table, some experiments on clay which I calcined after mixing with it a little lime.

Table No. XVIII.

| No. of the mortar. | Composition of the mortar. | | | No. of days required to harden in water. | Weight supported before breaking. |
|---|---|---|---|---|---|
| | | | | days | lbs. |
| 1 | Fat lime slaked to powder and measured in powder . .<br>Dust from Holsheim clay . | 1<br>2 | 3 | 12 | 319 |
| 2 | Lime the same . .<br>Same clay calcined with 0.10 of lime | 1<br>2 | 3 | 23 | 169 |
| 3 | Obernai lime slaked to powder and measured in powder .<br>Dust of Holsheim clay . . | 1<br>2 | 3 | 10 | 440 |
| 4 | Obernai lime do. . .<br>Same clay calcined with 0.10 of lime | 1<br>2 | 3 | 23 | 216 |

## *Observations on the experiments of Table* No. XVIII.

To make the above experiments, I slaked fat lime to dry powder, and fixed the quantity by measuring in powder: and I took Holsheim clay of which the composition is given at p. 378: vol. xx; it contains no lime. I calcined a portion of this clay in a crucible placed in a reverberatory furnace, keeping it at a red-heat during twelve hours. I took the same clay, mixed it with one-tenth its volume of fat lime reduced to paste, and heated the mixture in the same way and for the same time, as the clay alone. I then made mortars 1 and 3 of the above table, mixing fat lime and the Obernai hydraulic lime, with the clay dust that contained no lime: the numbers 2 and 4 were made with the clay dust mixed with one-tenth of lime.

The results of the table show that the mortar made with fat lime, and clay dust containing lime, gave a resistance only one half of that obtained with same lime, and clay dust containing no lime. The table shows that I got like results with mortars made of Obernai lime. It will also be seen that the hardening was slower, by one half, with the dust containing lime, than with that without lime. Besides, these mortars took much more time to harden than they should have taken; this is owing to the clay dusts having been calcined in a crucible, and to the experiment having been made in winter.

Mr. Sganzin states, page 27 of his *cours de construction* that the officers of Engineers who constructed the sluice-bridge at Alexandria reburnt their brick dust to a high degree; and he says it was because, before this operation, the mortars melted (*se délayait*) in the water. Mr. Vicat also, mentions this process which he approves, but for another reason; his opinion is that energetic puzzalonas suit better with fat lime than with hydraulic lime; he has remarked that on highly heating puzzalona, it loses all its energy, and I have obtained the same effect. But the lime used in building the Alexandria bridge was Casal lime, which is eminently hydraulic. Mr. Vicat thinks, therefore, that the brick dust was calcined to diminish its energy, so that it might make better mortar with the Casal lime. This is a great error. The officers of Engineers in calcining this brick dust to a high degree, committed a serious fault as I shall prove. But it is first necessary to show in what the error of Mr. Vicat consists. This Engineer relies on the principle, that mortar made of hydraulic lime, sand, and good cement, is superior to that made of lime and cement without sand. The first experiments of my table, Nos. 2 and 3, also show, that with good hydraulic lime, sand and trass or puzzalona, I obtained better results than with lime and trass or puzzalona without sand. But if we refer to table No. XIII, we shall see that, with a few exceptions, I obtained similar results with fat lime. If we compare the results of Nos. 9, 10, 11 and 12, all made of the same lime from marble, same trass and puzzalona, we see that if No. 9, containing sand, is inferior to No. 10, containing only lime and trass, on the other hand No. 11 which contains sand, is superior to No. 12 containing puzzalona without sand. To complete the conviction, it will suffice to cast the eyes over table No. XVIII; wherein we see that by the addition of one-tenth of lime to the Holsheim clay, and the degree of burning to which I submitted it, I considerably diminished the energy of this factitious trass: but it appears that this slightly energetic clay dust, gave, both with common lime, and with the Obernai hydraulic lime, a result only one half as good as that obtained with the same lime, and the clay dust in all its energy. The experiments cited, prove then, that energetic puzzalonas suit equally with very hydraulic lime and with fat lime. They prove that with these two kinds of lime it is in general more advantageous and economical to make mortars of lime, sand and puzzalona whether natural or artificial, than with lime and puzzalona only. If in certain cases, there is found to be a superiority in mortar without sand, we see that it is not great, and, on account of the considerable economy that results, we ought not to hesitate to use sand.

The observation cited by Mr. Sganzin, as to the sluice-bridge at Alexandria, would be entirely in opposition to the results Mr. Vicat and I have obtained by calcining clay dusts and puzzalonas to a high degree. We found that these substances thus calcined, lost all their energy, while, according to Mr. Sganzin, they require to be submitted to an elevated temperature. I did not doubt that Mr. Sganzin had been incorrectly informed as to what occurred at Alexandria; but, to be certain, I examined at the Depot of fortifications the documents relative to the works of that place, and I found, in a memoir of the *Chef de bataillon* Maynial, of the Engineers, dated 23 *brumaire an* 13, relating to this sluice-bridge what follows: The first season the floor (*radier*) was constructed of brick masonry in puzzalona mortar: the difficulty of procuring puzzalona, and its high price, led to the construction of a reverberatory furnace in which brick dust was reburnt to incandescence, so that when stirred it would flow like lava *(jusqu'a incandescence, de maniére que, lorsqu'on le remuait, on le voyait couler comme de la lave.)* The mixture of mortar, was one third of this reburnt brick-dust, one third sand, and one third Casal (lime,) and it produced the same effect as a like mixture of puzzalona."

We see that it was the difficulty of procuring puzzalona, that gave the idea of reburning the clay dust to the point of fusion, and that they were led to this degree of calcination by the false notion that puzzalona was lava—these two substances, being in fact, very different. It is not said in the memoir that the mortar made of this dust, before reburning it, melted in water, as Mr. Sganzin states: and it could not have been so, since they used the Casal lime, which is very hydraulic. We see, moreover, that it was not with a view to diminish the energy of the cement, and because it was to be used with very hydraulic lime, that it was reburnt; on the contrary they wished to impart to it the force of puzzalona, which they imagined had been melted like lava. The memoir says that this recalcined dust, produced the same effect as a like mixture of puzzalona. If they had mixed it with fat lime, there would have been a great difference between the results with this dust and those obtained in the same way with puzzalona. It is evident that their result ought to have been good, as it is stated to have been, at the end of the memoir, but it was owing entirely to the Casal lime being so eminently hydraulic. We have seen in the first tables that very hydraulic limes gave very good resistances without any admixture: if they had been mixed with broken nut shells, or with chopped straw, we should still have had a good result, but it would have been very wrong to attribute the result to those substances. By reburning the brick dust at so high a heat, they destroyed all its hydraulic properties; and they would have had as good a mortar by mixing this very hydraulic lime with sand, instead of the dust they used; and at a much cheaper rate. I repeat then that they committed a great fault at Alexandria in reburning the clay dust thus highly, since they necessarily caused it to part with all its hydraulic properties, and, in order to do this, encountered great expense. Before calcining the dust, if they thought proper to use it, they should have tried it with a little fat lime, to ascertain whether, or not, it would be advantageous to burn it more. I have enlarged on this example of the works of Alexandria, to show how important it is not to have false ideas as to puzzalonas, or the substances which are substituted for them. I proceed now to repeat other experiments that I made with diverse clays mixed with lime and calcined to different degrees.

Table No. XIX.

| No. of the mortar. | Composition of the mortars. | | | The clay having been burnt with lime. | | The clay having been burnt with bricks. | |
|---|---|---|---|---|---|---|---|
| | | | | H | W* | H | W |
| | | | | days | lbs. | days | lbs. |
| 1 | Fat lime slaked to powder & measured in powder<br>Trass . . . . | 1<br>2 | 3 | | | | |
| 2 | Lime the same . . .<br>Puzzalona . . . | 1<br>2 | 3 | | | | |
| 3 | Lime the same . . .<br>Dust of Holsheim clay . . | 1<br>2 | 3 | 25 | 187 | 15 | 275 |
| 4 | Lime the same . . .<br>Dust of Holsheim clay with lime water | 1<br>2 | 3 | 25 | 143 | 15 | 286 |
| 5 | Lime the same . . .<br>Dust of Holsheim clay with 0.01 of lime | 1<br>2 | 3 | 25 | 165 | 15 | 297 |
| 6 | Lime the same . . .<br>Dust of Holsheim clay with 0.02 of lime | 1<br>2 | 3 | 30 | 110 | 10 | 319 |
| 7 | Lime the same . . .<br>Dust of Sufflenheim clay . . | 1<br>2 | 3 | 25 | 165 | 15 | 297 |
| 8 | Lime the same . . .<br>Dust of Sufflenheim clay with lime water | 1<br>2 | 3 | 25 | 220 | 15 | 286 |
| 9 | Lime the same . . .<br>Dust of Sufflenheim clay with 0.01 of lime | 1<br>2 | 3 | 25 | 143 | 15 | 286 |

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*In this table and several others which follow, the columns marked H, express the number of days the mortar required to harden in water, and those marked W, indicate the weights supported before breaking. Au.

Table No. XIX.—(Continued.)

| No. of the series. | Composition of the mortars. | | | The clay having been burnt with lime. | | The clay having been burnt with bricks | |
|---|---|---|---|---|---|---|---|
| | | | | H | W | H | W |
| 10 | Lime the same . . .<br>Dust of Sufflenheim clay with 0.02 of lime | 1<br>2 | 3 | 25 | 121 | 12 | 275 |
| 11 | Lime the same . . .<br>Dust of pipe clay . . | 1<br>2 | 3 | 25 | 264 | 15 | 308 |
| 12 | Lime the same . . .<br>Dust of pipe clay with lime water . | 1<br>2 | 3 | 25 | 264 | 15 | 330 |
| 13 | Lime the same . . .<br>Dust of pipe clay with 0.01 of lime . | 1<br>2 | 3 | 25 | 275 | 15 | 341 |
| 14 | Lime the same . . .<br>Dust of pipe clay with 0.02 of lime . | 1<br>2 | 3 | 25 | 275 | 12 | 363 |

### *Observations on the experiments of Table* No. XIX.

To make the above experiments I took three kinds of clay, that of Holsheim, of Sufflenheim, and the pipe clay of the environs of Cologne: the composition of these clays may be seen at p. 378, vol xx. I made four bricks of each of these clays: the first contained no foreign substance: the second was made by adding a quantity of lime water equal to the bulk of clay; the third by adding one per cent. of fat lime in paste, and the fourth by adding two per cent of the same lime; they were placed in a lime kiln in the midst of the lime.* With each of the same clays I made, also, four other similar bricks which I placed in the same kiln with the common bricks. Lastly, having calcined these cements, I made the mortars which are given in the table, taking one part of fat lime, measured in powder, to two parts of each of these cements. No. 1 and 2, were made of the same lime and trass or puzzalona, to serve as comparisons with the other experiments. The mortar of trass hardened in six days, and broke under a weight of 264 lbs: that of puzzalona hardened in four days and supported 352 lbs. before breaking. The hardening has in general been a little slower; although these experiments were made at the end of summer. That may possibly be owing to the degree of burning of the lime.

On examining the above table we shall remark that all the clays that were burned with the lime, including the natural clays, gave results, less good, than when burned with the bricks; this difference is much greater with the clays which contain lime; we see that when burned with the bricks the Holsheim clay, and the pipe clay, gained a little by the addition of a small quantity of lime, while the Sufflenheim clay, on the contrary, lost a little. When they were burned with the lime, the Holsheim clay lost strength; that of Sufflenheim presented anomalies which I cannot explain, and the pipe clay was but little changed.

The Holsheim clay being most at command. I made with it several mixtures of lime up to one tenth, and I burned them in the same way as the above clays: the following table contains the results.

*Throughout all Alsace, they burn lime in large square, and elevated kilns, lime is put at bottom, bricks are placed above the lime, and tiles above the bricks: they burn with wood, which is placed at the bottom: so that the lime is most highly heated, and the tiles the least. Au.

## Table No. XX.

| No. of the series. | Composition of the mortars. | | | Clay burned with lime. | | Clay burned with bricks. | |
|---|---|---|---|---|---|---|---|
| | | | | H | W | H | W |
| | | | | days | lbs | days | lbs |
| 1 | Fat lime measured in paste<br>Trass | 1<br>2 | 2 | | | | |
| 2 | Lime the same<br>Puzzalona | 1<br>2 | 3 | | | | |
| 3 | Lime the same<br>Dust of Holsheim clay | 1<br>2 | 3 | 25 | 253 | 15 | 396 |
| 4 | Lime the same<br>Dust of Holsheim clay with 0.01 of lime | 1<br>2 | 3 | 25 | 209 | 15 | 319 |
| 5 | Lime the same<br>Dust of Holsheim clay with 0.02 of lime | 1<br>2 | 3 | 25 | 242 | 15 | 297 |
| 6 | Lime the same<br>Dust of Holsheim clay with 0.03 of lime | 1<br>2 | 3 | 25 | 231 | 15 | 286 |
| 7 | Lime the same<br>Dust of Holsheim clay with 0.04 of lime | 1<br>2 | 3 | 25 | 253 | 15 | 341 |
| 8 | Lime the same<br>Dust of Holsheim clay with 0.05 of lime | 1<br>2 | 3 | 25 | 275 | 15 | 352 |
| 9 | Lime the same<br>Dust of Holsheim clay with 0.06 of lime | 1<br>2 | 3 | 25 | 231 | 15 | 297 |
| 10 | Lime the same<br>Dust of Holsheim clay with 0.07 of lime | 1<br>2 | 3 | 25 | 198 | 15 | 275 |
| 11 | Lime the same<br>Dust of Holsheim clay with 0.08 of lime | 1<br>2 | 3 | 25 | 198 | 15 | 286 |
| 12 | Lime the same<br>Dust of Holsheim clay with 0.09 of lime | 1<br>2 | 3 | 25 | 231 | 15 | 297 |
| 13 | Lime the same<br>Dust of Holsheim clay with 0.10 of lime | 1<br>2 | 3 | 25 | 242 | 15 | 286 |
| 14 | Lime the same<br>Dust of Holsheim clay with 0.04 of lime | 1<br>2 | 3 | | | 4 | 187 |
| 15 | Same mortar | | | | | 4 | 209 |
| 16 | Same mortar | | | | | 3 | 297 |
| 17 | Same mortar | | | | | 3 | 385 |

### *Observations on the experiments of Table* No. XX.

The above experiments were made in the same manner as those of table No. XIX, as to the burning of the clays; but in proportioning the mortars I took one part of lime in paste to two parts of cement. I made two comparative experiments, No. I and No. 2 with trass and puzzalona. The mortar with trass hardened in four days and supported 319 lbs; that with puzzalona hardened in three days and broke under a weight of 286 lbs. We have seen in table No. XIII, an exactly similar mortar support 495 lbs. Whence it appears that with puzzalona as with trass, results are various.

The present table concurs with No. XIX in showing that the cements calcined with the lime gave inferior results to those calcined with the bricks. This table shows also that the proportions of lime mixed with the clay, which gave the best results for the degrees of calcination tried, were four or five per cent; but here. the best result obtained from clay mixed with lime, is inferior to that of No. 3 where there was no lime. It appears that the mortars of the two tables whereof the clay had been calcined with 0.02 of lime do not greatly differ. A greater difference observable between the mortars No. 3 of the two tables, neither of which contain lime, may be owing to two circumstances: the first is, that in table No. XIX the proportions were adjusted with lime in powder, while in No. XX, they were fixed with lime in paste; the second is, that the cement of mortar No. 3 in the present table may have received a more suitable degree of calcination than that of table No. XIX.

All the four mortars No. 14, 15, 16 and 17 were made with clay that had been mixed with 0.04 of lime, but they were heated to different degrees in another kiln, and gave different results. Cement No. 14 was burned with the tiles and placed in the upper part; No. 15 was placed in the middle of the kiln; No. 16 between the tiles and the bricks, and No. 17 in the middle of the bricks. Whence it appears that No. 14 was least and No. 17 most heated. This last mortar gave about the same resistance as No. 3 which contained no lime.

There are several anomalies in the last column of table No. XX which appear to me to be due to the degree of calcination. We notice, in fact, that in a brick kiln, not only the different layers sustain different degrees of heat, but even the bricks in the same layer are not all burned to the same degree. All the mortars of the last column of the last two tables, required about fifteen days to harden, with the exception of the last four which hardened in the short space of three to four days. I attribute this effect to the circumstance that these four cements were placed by the side of one of the flues left in the mass of bricks in order to distribute the heat; and thus they were exposed, during the burning, to a current of air which contributed to the promptitude of the induration, as I shall have occasion to show

The experiments given in tables Nos. XVI, XVII, XVIII, XIX and XX, show that the presence of lime has great influence, when it exists in the state of carbonate in the clays, as to the effect of calcination upon them; because the heat disengages a great part of the carbonic acid, and the lime mixed in the clay, causes the beginning of vitrification, which is distructive of all hydraulic properties in these cements. These experiments show, besides, 1st. that clay containing no lime requires a rather high calcination to form good artificial puzzalonas, and that the heat required to burn bricks suitably, is about the proper degree for such cements: 2nd. that when the clays contain as high as one tenth of carbonate of lime, the temperature used to burn tiles is sufficient: 3rd. that this degree of heat is too great for them, provided they contain from a tenth to a fifth of carbonate of lime, as sometimes happens, but that good results may still be got by burning them with a lower heat than that required for tiles: 4th. it does not appear that the presence of lime in clays tends to make the cements more energetic. If it gives energy to some clays, it is but slight: and there may result from the mixture, if the burning be carried too high, a loss of all hydraulic property. At the close of the chapter I shall explain all the means necessary to the fabrication of good artificial puzzalona.

Among the substances which, after lime, occur most frequently in clays, is magnesia. I, in consequence, made the following experiments with Holsheim clay and various proportions of carbonate of magnesia.

Table No. XXI.

| No. of the mortars | Composition of the mortars. | | | No. of days required to harden in water. | Weight supported before breaking. |
|---|---|---|---|---|---|
| | | | | days. | pounds. |
| 1 | Fat lime measured in paste . .<br>Dust of Holsheim clay . . | 1<br>2 | 3 | 20 | 330 |
| 2 | Lime the same . . .<br>Dust of the same clay with 0.01 of carbonate of magnesia . . | 1<br>2 | 3 | 20 | 341 |
| 3 | Lime the same . . .<br>Dust of the same clay with 0.03 of do. | 1<br>2 | 3 | 20 | 330 |
| 4 | Lime the same . . .<br>Dust of the same clay with 0.05 of do. | 1<br>2 | 3 | 20 | 341 |
| | Lime the same . .<br>Dust of the same clay with 0.07 of do. | 1<br>2 | 3 | 20 | 330 |
| 6 | Lime the same . . .<br>Dust of the same clay with 0.10 of do. | 1<br>2 | 3 | 20 | 330 |
| 7 | Lime the same . . .<br>Dust of the same clay, highly heated, with 0.05 of carbonate of magnesia | 1<br>2 | 3 | 20 | 231 |

## *Observations on the Experiments of Table* No. XXI.

I made the above mixtures of Holsheim clay with carbonate of magnesia in the same manner as, in the preceding tables, the mixtures of clay and lime. We see that the hardening was slower than usual; but this is owing to the experiments having been made during very cold weather in the month of January.

These clays were placed in the lime kiln between the bricks and the tiles, and we see by the result of No. 1 that the degree of heat was not quite sufficient to impart to this clay all the energy of which it is susceptible. We see also, that at this degree of heat, the carbonate of magnesia has had no great effect in transforming this clay into puzzalona. The cement No. 7 was more highly heated, being placed between the bricks and the lime: the clay of this number contained the same quantity of carbonate of magnesia as No. 4 and we see that it supported 110 lbs. less. We should not conclude that this effect is due to the magnesia; because the Holsheim clay loses, when alone, much of its force when too highly heated, as we see by No. 1 of table XXIII. It appears, therefore, that magnesia is nearly passive in the perfecting of artificial puzzalonas.

Clay, we know, is a mixture of silex and alumine: I, in consequence, made the following experiments, adding sand to the clay which I heated.

## Table No. XXII.

| No. of the mortars. | Composition of the mortars. | | | No. of days required to harden. in water. | Weight supported before breaking |
|---|---|---|---|---|---|
| | | | | days | lbs. |
| 1 | Fat lime slaked to powder and measured in powder . .<br>Dust of pipe clay heated for six hours in a reverberatory furnace . | 1<br>2 | 3 | 12 | 418 |
| 2 | Lime the same . .<br>Same clay deprived of part of its sand, and to which was added 0.10 of white sand pounded fine . . | 1<br>2 | 3 | 14 | 374 |
| 3 | Lime the same . .<br>Dust of clay No. 2 with 0.20 of sand do. | 1<br>2 | 3 | 15 | 378 |
| 4 | Lime the same . .<br>Dust of clay No. 2 with 0.30 of sand do. | 1<br>2 | 3 | 15 | 383 |
| 5 | Lime the same . .<br>Dust of clay No. 2 with 0.40 of sand do. | 1<br>2 | 3 | 15 | 473 |
| 6 | Lime the same . . .<br>Dust of clay No. 2 with 0.50 of sand do. | 1<br>2 | 3 | 15 | 462 |
| 7 | Lime the same . . .<br>Dust of yellow ochreous clay . | 1<br>2 | 3 | 16 | 187 |
| 8 | Lime the same . .<br>Dust of yellow ochreous clay, deprived of part of its sand . . | 1<br>2 | 3 | 20 | 143 |
| 9 | Lime the same . . .<br>Dust of clay No. 8 with 0.10 of white sand pounded fine . . | 1<br>2 | 3 | 20 | 165 |
| 10 | Lime the same . . .<br>Dust of clay No. 8 with 0.20 of sand do. | 1<br>2 | 3 | 18 | 176 |
| 11 | Lime the same . . .<br>Dust of clay No. 8 with 0.30 of sand do. | 1<br>2 | 3 | 16 | 189 |
| 12 | Lime the same . . .<br>Dust of clay No. 9 with 0.40 of sand do. | 1<br>2 | 3 | 18 | 154 |
| 13 | Lime the same . .<br>Dust of clay No. 8 with 0.50 of sand do. | 1<br>2 | 3 | 20 | 132 |
| 14 | Lime the same . .<br>Dust of clay called Rintzel . | 1<br>2 | 3 | 12 | 352 |
| 15 | Lime the same . . .<br>Dust of Rintzel clay deprived of part of its sand . . . | 1<br>2 | 3 | 10 | 418 |

### *Observations on the experiments of Table* No. XXII.

To make the first six experiments, I took the white clay which is sent from the environs of Cologne to Strasburg, to make pipes. The analysis of this clay, given in vol. xix, p. 378, shows that it contains very little iron, and that the alumine in it, is about one third of the silex. I took a portion of this clay, diffused it through a large quantity of water, and decanting it several times, deprived it of a part of its silex. I then made the mortar No. 1 with the natural clay: the other mortars up to No. 6 inclusive were composed with the clay deprived of part of its silex, to which I added, successively, the portions of sand stated in the table. The sand which I used was white and silecious: it was pounded very fine and mixed with the clay.

I omitted composing a mortar of lime, and this white clay deprived of part of its sand, like that, No. 8, made of another kind of clay. The clay of the first six numbers was calcined during six hours in a reverberatory furnace. No. 2, which had less sand than No. 1, gave a result less strong. The quality of the succeeding mortars improves up to No. 5, to which I had added 0.40 of sand; No. 6, which contained 0.50 of sand, was inferior to No. 5.

The experiments from No. 7 to No. 13 were made with a very greasy clay: a yellow ochreous earth of which I had not the analysis. I treated this clay like the other, that is to say, I took a portion which I washed in a great quantity of water, decanting several times to separate a portion of the sand it contained. No. 7 was made with the natural ochreous earth: No. 8 with the clay deprived of a portion of its sand. To make the following mortars up to No. 13, I added to the washed clay the several portions of sand indicated in the table; these clays, like the pipe clay, were heated for six hours in a reverberatory furnace, keeping them at a low red heat (*rouge tendre.*) We see that, with this clay as with the pipe clay, we obtained an inferior result when it was deprived of much of its sand, and that its energy was augmented by adding a little sand, up to a certain quantity, beyond which it went on diminishing. The comparison of the above experiments with ochreous clay and pipe clay, shows that ochreous earths are not, as was for a long time believed, to be preferred in forming artificial puzzalonas: several other results confirm this remark.

The experiments No. 14 and 15 were made with a clay which is found in the environs of Haguenace, and is used for various purposes; this clay is gray, and contains no lime: it is refractory. It is used in the construction of furnaces for heating madder. On working it in the hands, it is perceived to contain a considerable quantity of sand. No. 14 is composed of the natural clay: in No. 15, the clay is deprived of part of its sand, and in this state it is much more greasy to the touch. A comparison of No. 14 and 15 shows that this clay gave the best result when deprived of part of its sand.

The experiments made with the above three kinds of clay prove that clays containing a great quantity of sand are not so suitable for making artificial puzzalonas as those which, having more alumine, are greasy to the touch. When clays contain one part of alumine to three of silex, they are very greasy: they are also quite greasy when the proportion is one to five, but beyond this they become meagre: it is therefore amongst the clays a little greasy, that we should seek for those whereof to make artificial puzzalona.

We have seen, according to the analysis, by Mr. Berthier, of trass and puzzalona, that these substances contain potash and soda. I therefore mixed these with the clays to be heated, and the following are the results.

## Table No. XXIII.

| No. of the mortar. | Composition of the mortars. | | | Clay having been burned with bricks. | | Clay having been burned with lime. | |
|---|---|---|---|---|---|---|---|
| | | | | H | W | H | W |
| | | | | days. | lbs. | days. | lbs. |
| 1 | Fat lime measured in paste .<br>Dust of Holsheim clay . | 1<br>2 | 3 | 15 | 330 | 25 | 99 |
| 2 | Lime the same . .<br>Dust of same clay with 1-10 of solution of soda at 5° . | 1<br>2 | 3 | 15 | 319 | | |
| 3 | Lime the same . .<br>Dust of same clay with 1·5 do. | 1<br>2 | 3 | 15 | 308 | | |
| 4 | Lime the same . .<br>Dust of same clay with 1-4 do. | 1<br>2 | 3 | 15 | 297 | | |
| 5 | Lime the same . .<br>Dust of same clay with 1-3 | 1<br>2 | 3 | 15 | 297 | | |
| 6 | Lime the same . .<br>Dust of same clay with 1-2 . | 1<br>2 | 3 | 15 | 286 | 15 | 297 |
| 7 | Lime the same . .<br>Dust of same clay with 1-10 of solution of potash at 5° . | 1<br>2 | 3 | 15 | 341 | | |
| 8 | Lime the same . .<br>Dust of same clay with 1-5 do. | 1<br>2 | 3 | 15 | 363 | | |
| 9 | Lime the same . .<br>Dust of same clay with 1-6 do. | 1<br>2 | 3 | 15 | 374 | | |
| 10 | Lime the same . .<br>Dust of same clay with 1-3 do. | 1<br>2 | 3 | 15 | 363 | | |
| 11 | Lime the same . .<br>Dust of same clay with 1-2 do. | 1<br>2 | 3 | 15 | 341 | 25 | 264 |
| 12 | Lime the same . .<br>Dust of same clay with 1-2 of solution of saltpetre at 5° . | 1<br>2 | 3 | | (*) | 25 | 264 |
| 13 | Lime the same . .<br>Dust of same clay with 1-2 of solution of saltpetre at 10° | 1<br>2 | 3 | | | 25 | 242 |
| 14 | Lime the same . .<br>Dust of same clay with 1-2 of solution of com. salt at 5° . | 1<br>2 | 3 | 15 | 330 | 25 | 264 |

### *Observations on the experiments of Table* No. XXIII.

To make the above experiments I took Holsheim clay and mixed it with various quantities of solutions of soda standing at 5° of the *pèse acid.* The quantities of solutions of soda that the clays contain are taken with reference to the volume of clay. I did the same with potash, as is shown in the numbers from 7 to 11. Nos. 12 and 13 have the clay mixed with water containing saltpetre; and No. 14 has the clay wet with salt water.

The clays of the first eleven numbers of the first column of the table were heated in a lime kiln, between the tiles and the bricks, so as to give them only a moderate heat. Those of No. 1, 6 and 11 of the second column were burned with the lime, and subjected to a very high heat.

If the result of the first eleven numbers, wherein the clay was heated with bricks, be observed, it will be seen that the first of those which contain soda, differ but little from No 1 which contains none, but that the resistances, in the succeding numbers, go on diminishing a little, as the proportion of soda was increased. With potash, I obtained a different result; the resistance of the mortars augmented up to No. 9, and afterward diminished. The clays placed between the tiles and the bricks received a degree of heat rather too slight—for No. 1 supported a weight of only 330 lbs, while we have seen that this clay could sustain a weight of 396 lbs, when the clay had been properly calcined.

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*This mortar broke, on being cut, but was very hard. Au.

The clays No. 1, 6 and 11, which had been placed in the middle of the lime, received a much higher degree of heat than ordinary: for the cement No. 1 had become of a slate blue, while it is commonly of a liver colour (*d'un rouge foncé)* a good deal like the puzzalona that I used.

We see that mortar No. 1 lost much of its strength when its cement had been calcined with the lime, since, instead of 330 lbs, it supported only 99 lbs: but it is singular that Nos. 6 and 11 which had received the same degree of heat, and of which the cements were equally blue, offered a resistance much greater than the corresponding one of No. 1. The effect of soda and potash, then, has been to prevent this clay from losing a great part of its hydraulic property in consequence of a too high calcination. I thought I should obtain an opposite result, because these substances, heated with silex, form glass, and all vitrified substances make very bad puzzalonas. But these gave no trace of vitrification. I obtained a slight advantage by moistening the clay with the lye of ashes standing at 5°.

No. 12 and 13 are composed of the same clay tempered with water containing saltpetre (nitrate of potash.) This trial was made in duplicate; the cement in one being but little, and in the other, much burnt. Unfortunately the first mortar broke on being cut to the proper size; the second experiment gave a good result, like that obtained from potash. This trial was designed to ascertain whether the *aqua-fortis cement*, which has been a long time in use, merits its high reputation. This cement is an argillaceous residue, derived from distillation of nitrate of potash and clay, to extract nitric acid. This operation is performed in matrasses of stoneware or glass: the residue being a combination of ferruginous clay, potash and some alkaline salts. Being pulverized, this is what is called *aqua-fortis cement (le ciment a l'eau-forte.)* Very good results are got from it. But I presume, after what has been shown above, that the quality of the cement must be very variable, according to the composition of the clays used, and especially, as they may sometimes contain lime. It is unfortunate that the mortar No. 12, of which the clay had been moderately calcined, was broken. We see that the trial, in the case where the clay had been highly calcined, gave an average result. No. 13 only differed from No. 12, in being mixed with water more highly charged with nitrate of potash. The experiment of No. 13 having given a result sensibly superior to the No. 1 corresponding, I am induced to think that the *aqua-fortis cement* may be very good; but these experiments should be repeated.

I have stated above that the Dutch make a very good factitious trass, by calcining a clay which they extract from the bottom of the sea; I, consesequently, made No. 14, of the Holshiem clay, and salt water. If we compare No. 14 of the first column and the corresponding No. 1, we see that the result is the same. If we make the same comparison in the second column, which comprises the clays calcined with the lime, we shall remark that the clay mixed with salt water has a great superiority. We have a right to conclude then that the marine salt acted like the potash and soda—

that is to say, it prevented a high degree of calcination from depriving the clay of a great portion of its hydraulic property. It results from this, that when fabricating artificial puzzalonas near the sea, it will be proper to try whether, on mixing the clays with salt water, the bad effects of too high a heat will be prevented. This would be advantageous, because it is difficult to give an equal degree of heat to a kiln, when the temperature is high. These experiments should be made at different degrees of temperature, so as to compare results. Even in the interior of the country, it would not be expensive to add salt to the clays which are to be calcined—using a solution of common salt.

Although, according to table No. XXIII, soda, mixed with Holsheim clay, gave results a little inferior to those given by the natural clay, it was not so with potash. When the proportions were not too great, potash gave results sensibly better. This resort cannot always be had, because of the cost of the materials, and of the operation of mixing. I shall show in the sequel that it is easy to arrive at the same end in a less expensive mode, by choosing proper clays; but the observation of the effects of potash will serve to throw some light on the theory of puzzalona and trass.

The hardening of the mortars in the above table was rather slow; one of the causes was, that the experiments were made in the beginning of winter. The mortars of the first series all took about fifteen days to harden, and those of the second, twenty-five days.

I now proceed to give the results obtained with the dust of clays found near Strasburg, or carried thither for various uses.

Table No. XXIV.

| No. of the mortar. | Composition of the mortars. | No. of days required to harden in water. | Weight supported before breaking. |
|---|---|---|---|
| | | Days. | lbs. lbs. |
| 1 | Fat lime, sand and trass | 4 to 20 | 231 to 510 |
| 2 | Do. and Trass | 3 to 16 | 264 to 583 |
| 3 | Fat lime, sand and puzzalona | 4 to 5 | 352 to 499 |
| 4 | Do. and puzzalona | 3 to 5 | 286 to 550 |
| 5 | Do. sand, and dust of Frankfort clay | 4 to 6 | 418 to 561 |
| 6 | Do. and dust of Frankfort clay | 3 to 5 | 422 to 578 |
| 7 | Do. sand, and dust of Cologne clay | 14 to 18 | 286 to 473 |
| 8 | Do. and dust of Cologne clay | 12 to 15 | 308 to 495 |
| 9 | Do. sand, and Dust of Wissemburg clay | 14 to 16 | 242 to 429 |
| 10 | Do. and dust of Wissemburg clay | 12 to 15 | 220 to 462 |
| 11 | Do. sand, and dust of Holsheim clay | 12 to 18 | 253 to 418 |
| 12 | Do. and dust of Holsheim clay | 10 to 15 | 275 to 440 |
| 13 | Do. sand, and brick dust of Sufflenheim | 16 to 20 | 231 to 407 |
| 14 | Do. and brick dust of Sufflenheim | 15 to 18 | 253 to 462 |
| 15 | Do. sand, and dust of Kilbsheim clay | 10 to 12 | 231 to 308 |
| 16 | Do. and dust of Kilbsheim clay | 8 to 10 | 253 to 319 |
| 17 | Do. and dust of whitish bricks of Ackenheim | 12 to 15 | 242 to 286 |
| 18 | Do. and dust of red bricks of Ackenheim | 25 to 35 | 77 to 121 |
| 19 | Do. and dust of yellow bricks of Kehl | 25 to 40 | 55 to 77 |
| 20 | Do. and several kinds of dust from Depot | 10 to 30 | 121 to 330 |
| 21 | Do. and slate dust | 12 to 15 | 319 to 451 |
| 22 | Do. and "*ciment de sanguine*" | 15 | 352 |
| 23 | Do. and dust of yellow ochre | 18 | 297 |
| 24 | Do. and two parts of Paris cement | 4 | 187* |
| 25 | Do. sand, and Paris cement | 5 | 99* |

*These two mortars were cracked.

*Observations on the experiments of Table* No. XXIV.

I have united in the above table several trials to produce hydraulic mortar with fat lime and different kinds of clay calcined, without adding any thing to them. At the top of the table, I put the results obtained with trass and puzzalona. I have united all the experiments of the same kind in a single statement, because I sometimes made the mortars by taking the lime in a powder, and sometimes in paste. The proportions of sand, trass and cement, also varied. We see that it would have required a very extended table to separate all these experiments. By uniting them, as I have done, the general result may be seen.

No. 1 comprises mortars composed of various fat limes, sand and trass; several causes contributed to vary the hardening and the resistance: these are, principally, the quality of the trass: the time it was left in the air after being slaked with a little water; the proportion, and, lastly, the season of the year. This observation applies to all the following mortars. The weakest resistance of the mortars No. 1, is 231 lbs., and the strongest 510 lbs.

No. 2 comprises a series of experiments made with fat lime and trass, without sand, the resistance varied from 264 to 583 lbs.; this last result is the greatest that I obtained in all my experiments. This mortar was made in summer, with lime that had been slaked to powder for two months; it is probable that the piece of trass was of an unusually good quality.

The two series of experiments under Nos. 3 and 4, were made with fat lime, sand and puzzalona; and with lime and this last substance without sand. The puzzalona behaved like the trass. From the column showing the hardness, it might be supposed that the puzzalona mortars hardened quicker than those made of trass, but it is not so. In the instances of the trass, the mortars were made in winter as well as in summer; but with the puzzalona, the experiments were made only in summer, and during that season, the hardening was about the same for the two substances. There is, however, a light advantage in favor of puzzalona, but which cannot be estimated at more than half a day. I therefore, as stated above, regard these two substances as having given me like results.

Nos. 5 and 6, comprise experiments made with clay brought from a village called Kinglesburg, twelve leagues from Frankfort; this clay is used at Strasburg to make alum; it is preferred to the clays of the vicinity because it contains almost no iron; they calcine it for thirty-six hours before dissolving it in sulphuric acid. When this clay is in its crude state, it is blackish, owing to vegetable remains. By calcining it a little, it becomes blue; in which state it gives bad results; when strongly calcined, it becomes very white, and forms an excellent artificial puzzalona, as appears from those two numbers, 5 and 6. The analysis of this clay shows that it contains no lime, and the iron found in it in small quantity may be considered as without action. It has been an error, therefore, to attribute great influence to iron in the improvement of artificial puzzalonas: these experiments, 5 and 6, showing that a very good artificial puzzalona may be obtained from a clay containing neither iron nor lime. The analysis of this clay exhibits the alumine as existing in the proportion to the silex, of about three to five, (see vol. xx, p. 378:) it is very greasy to the touch. Mortars made of this cement and sand, sometimes gave superior results to those in which there was no sand, and sometimes inferior, as happened with trass. The hardening was always as quick as with puzzalona; which I shall explain in the sequel.

The series Nos. 7 and 8, were made of the white clay which is brought from Cologne to Strasburg to make pipes. We see, at page 378, vol. xx, that it contains no lime and very little iron. The table shows that the mortar made of this cement gave very good results also, although the clay does not contain as much alumine as that from Frankfort; the hardening was slower.

The mortars Nos. 9 and 10, were composed of clay from the environs of Wissemburg; it is used at Strasburg to make common pipes. This clay contains no lime; it is, as it were, marbled with veins of red oxide of iron; the analysis indicates but little more iron than the Cologne clay, but it is because the specimen analysed was taken from between the veins. The table shows the results to have been very good.

The series Nos. 11 and 12, were made of Holsheim clay; which contains no lime, but a quantity of iron; it is of a reddish color, and quite greasy to the touch, although the proportion of alumine to the silex is hardly one to four. The dust of this clay gave very good results, but the hardening was slow.

The series Nos. 13 and 14, were made of bricks of Sufflenheim, of which the clay contains no lime, but a considerable quantity of iron; it is not very greasy, and, indeed, the alumine is only about one seventh of the silex. The cement of which I made the several mortars, were made from bricks which I reduced to powder; we see that these results are also very good.

The series Nos. 15 and 16, were made of Kolbsheim bricks; the clay of this kiln is quite greasy—containing one of alumine to four of silex. It contains a considerable quantity of iron, and more than one tenth of lime; the results were not so good as with Holsheim and Sufflenheim cements. The trials were made with brick dust; I did not make many, and it is possible that I used bricks that had been too much burned.

Nos. 17 and 18 were made of the dust of Achenheim bricks. No. 17, of the dust of a whitish brick, containing but little iron and little lime. The results were pretty good. No. 18 was made of the dust of bricks which are very red—containing much iron, and a great quantity of lime. The mortars of this cement were very bad. I am not certain whether the bricks of No. 17 were made of clay from Achenheim itself, or its environs.

The experiments under No. 19, were made with yellow bricks from Khel. I do not know the analysis of this earth, but it is a yellow ochreous earth, containing a considerable quantity of lime; we see that I got bad results, only.

The series No. 20, was made with various cements taken from the place of deposit of a contractor—being derived from a mixture of various tiles and bricks. We see that I had sometimes good results, and sometimes quite bad; as might be expected from the manner in which the cements were composed.

The experiments under No. 21, were made of slates from the neighborhood of Mayence. I do not know the analysis, but being assured that they contain little or no lime, I calcined them highly, and they gave me a very good cement. I had occasion to notice that, to obtain a good result, it was necessary to calcine these slates until they began to take a light red color on cooling, which requires quite a high heat. I am surprised that in the experiments of Mr. Gratien, senior, at Cherbough, better results were not obtained; this appears to me to have been owing to the degree of burning, which they did not sufficiently vary, to ascertain the best. I presume that good cements could be made of the tender strata found near the surface of the slate quarries, and which are too tender to be formed into slates. They will be easier to reduce to powder after calcination.

No. 22 was made of a cement obtained from a substance known under the name of "*sanguine*;" the resistance of this mortar was quite good.

Mortar No. 23 was made of cement resulting from the calcination of a clay known by the name of yellow ochre; the result was less than that of the preceding mortar. It appears to me that the yellow ochreous clays are not so good as others for the production of artificial puzzalonas; it is possible it may be owing to the oxide of iron being found therein in combination with the silex, as shown by Berzelius.

In the *Annales de Chimie* of 1824, it is stated that in 1823, Mr. Saint Leger made factitious puzzalona at Paris from the clay of Passy and Meudon, in the proportion of three parts of these clays to one of lime slaked and measured in paste. In 1825, I made two mortars of some cement given me by Mr. Saint Leger. Mortar No. 24 is an experiment therewith; it was made of one part of fat lime measured in paste, mixed with two parts of this cement: this mortar hardened promptly. At the end of a year, I submitted it to rupture, with the others; but it was cracked, and supported only 187 lbs.

No. 25, was made of the same lime, of sand, and of cement, in equal parts; this mortar hardens promptly; but it, also, was cracked, and bore only the light weight of 99 lbs. We shall see, in the second section, that I made of this cement a mortar which was exposed in the air for one year, and that it had so little consistence, that it crumbled easily in the fingers.

The bad results that I obtained from the cements of Mr. Saint Leger seem to be due to the quantity of lime which they mix with the clay in making the cement. I said in my memoir of 1822, of which an extract is contained in the Moniteur of January 22, 1823. "The substance of which it is most important to observe the proportions, is lime. If the argillaceous earth used contains a tenth, or more, of lime, and it be heated to the degree necessary to burn bricks properly, the trass obtained will be very bad; if this earth be heated to the degree employed to burn those bricks which are called *light burned bricks*, the trass will be of a mediocre quality only, but may be used in works not requiring prompt induration. It appears that a very small quantity of lime, as four or five per cent, in the clayey earths, far from injuring the quality of the puzzalona or trass, brings, on the contrary, the clay to that condition that the cement produced will cause the mortar to harden very promptly, and at the same time impart to it a high degree of force. When there is no lime in clay, a higher burning is required and the hardening is rather slower."

In 1822, therefore, I regarded lime as a substance to which the greatest attention should be paid, when it was found to be a natural constituent of the clays to be turned into puzzalonas; but that I considered it rather to be avoided than sought after; observing, nevertheless, that a small percentage of this substance was rather useful than injurious, with proper care in managing the heat. The expense of mixing lime with clays that are to be converted into puzzalonas, should, therefore, be avoided.

On mixing fat lime slaked to paste, with clay, I have observed a singular phenomenon, for which I have not been able to account: it is this, if clay be diffused through water, till we bring it to the consistence of clear sirup, and, after having brought the lime to the same state, the two mortars be mixed together, as soon as the mixture is made, it becomes so thick that it will be difficult to continue the operation without adding a considerable quantity of water. I do not know to what this is owing.

The results of experiments 18, 19 and 20, show how dangerous it would be to use, without examination, the first cements encountered. I will cite an example in point. When Marshal Vauban built the citadel of Strasburg, three great casemates were constructed in each of the two bastions which lie on the town side. The casemates of the right bastion are very dry, and they are often used as powder magazines. The casemates on the left were, on the contrary, very wet; the water filtered, every where, through the arches; all the casemates had caps of cement, but those of the right had been made of good, and those of the left, of bad cement. In 1808, they were obliged to make the caps of the casemates on the left anew. On breaking up the old caps, it appeared that they had been made of cement, (brick dust?) but that moisture had penetrated for a long time, and that several parts had scaled off. In the report on the reconstruction, it is said, "We followed vigorously, in the execution of this work, the method indicated by Mr. Fleuret. The cement was made under the supervision of a workman employed by him, and it was put on by masons practised in this kind of work. The thickness of the cap was two and four-tenth inches, and was composed of three layers of cement, applied successively with the trowel, and compacted by ramming. The last course was rammed, and afterwards polished off with a stone, until the cement had acquired such hardness as to receive no further impression." (Report of Captain Gleizes of the Engineers, January 30, 1808.)

We see that it was no want of precautions that caused the work to fail. Notwithstanding these precautions, the water, after ten years, filtered through every part of these arches, and they were again, necessarily, remade. On demolishing them a second time, it was observed that several portions of the three layers of mortar that had been successively placed to form the caps, had no connexion with each other. I think it is a great fault to make the caps of arches in successive layers; they should, in my opinion, be made of a single one, let the thickness be what it may. Mr. Fleuret attaches great importance to beating mortars well, and we shall see further on, that this is also an error. The caps at Strasburg failed the second time because they used fat lime, and brick dust? taken at hazard; it was found to have no hydraulic property, and the mortar had no consistence. Mr. Fleuret succeeded very well in making factitious stones, and water pipes, when he used the Metz lime; but a contractor at Phalsbourg who attempted to apply this process to the construction of the military fountain—using the materials of the country, failed in his work, and was ruined. At Landau, also, the caps of arches made according to the process of Mr. Fleuret, failed. The caps of the above casemates of Strasburg were constructed in 1819, with good materials: they succeeded well, and the casemates have become very dry. I thought it my duty to give these details to show how important it is not to use cements without a previous trial, because it is always an expensive substance, and if badly chosen, it may happen that the result is no better than if so much sand had been used instead thereof.

I am now about to state how I detected an important action exercised by the air in perfecting artificial puzzalonas. We may remark that all the experiments made with Frankfort clay, hardened very quickly, and gave great resistance. I took these clays from a certain furnace where they had been calcined for the purpose of making alum. Having, one day, burnt in a lime kiln, some bricks made of this clay, I was surprised to see that the hardening was much slower, although the degree of heat had been about the proper degree, as was easy to perceive by the color. Examining the construction of the two furnaces, I remarked that the bricks were burnt by being placed above the lime; that above the bricks tiles were placed, and, lastly, above all, pieces of burnt clay covered with fragments in such a way as to leave openings only in certain places, thereby directing currents of air into certain parts only of the kiln. It resulted from this arrangement, made with a view to save as much heat as possible, that only certain bricks and tiles were exposed, during calcination, to a current of air. I will remark, that the dust of these bricks always caused the mortars to harden more promptly than the others. On the other hand, I noticed that the hearth of the alum furnace was pierced with many holes, which caused a strong current of air throughout all the mass of clay submitted to calcination. Pl. I, Fig. 2, gives a plan and section of this furnace. The calcination is effected by wood placed in the lower arches. It then occurred to me that the reason why I obtained good results with this clay, and especially a rapid induration, might be, that at a high temperature the hydrate of alumine might absorb oxygen. I was led to this supposition because I had ascertained, page 318, vol. xx, that the hydrate of lime absorbed oxygen. I calcined a little clay in a current of air, and also a little in a close vessel, and I ascertained that the alumine that had been calcined in a current of air dissolved in sulphuric acid more easily than the other. This was a presumption for my hypothesis, but no proof. I had, likewise, heated in these two ways, a little alumine extracted from alum, and had made mortars by mixing it with lime from white marble. The mortar made of alumine burned in a current of air appeared to me to take consistence sooner than the other; but, after some time, both were equally soft, and at the end of a year had no consistence. This experiment seems to prove that alumine alone will not form puzzalona, and that it requires to be mixed with a certain quantity of silex; this result is besides in accordance with table No. XXII, in which we see that by taking away from clay too much sand, the energy of the cement was diminished, and that it was augmented on adding very fine siliceous sand. The alumine which I used having already been calcined and dissolved in sulphuric acid, to form alum, it is possible that this had taken from it the property of forming puzzalona, and the experiment should have been made with natural alumine; but this substance is very rare, and I had none at command. After these first essays, I made the last four experiments of table No. XX. We have seen that the hardening was very prompt; which was owing, as I said in speaking of those experiments, to the bricks being exposed to a current of air during the calcination. The bad mortar—the cement having been properly burned, gave a good resistance, and at the same time a very prompt induration. I then made the following experiments: I took Holsheim clay, of which I made two bricks; one of these bricks was of the natural clay, the other was of the natural clay mixed with 0.02 of lime in paste. I calcined these two bricks in a lime kiln, placing them where, as it seemed to me, they would be but little exposed to the current of air. I, at the same time, made balls of the size of a nut, of the same Holsheim clay, both in its natural state, and also mixed with 0.02 of lime, and afterward calcined these two kinds of balls in a reverberatory furnace, keeping them red during six hours, in a hessian crucible having a hole in the bottom. These last clays were, therefore, calcined in a current of air, and the former, not. The following results were obtained. The mortar of the natural clay heated in the lime kiln did not harden till the end of thirty days, and supported a weight of 385 lbs. before breaking; that which was made of the same clay mixed with 0.02 of lime, hardened in seventeen days, and broke under a weight of 352 lbs. The mortar made of the natural clay that had been heated for six hours in a current of air, hardened in five days; but it broke under a weight of 330 lbs. Lastly, the mortar made of the clay which contained 0.02 of lime, and which was, also, heated for the same time in a current of air, hardened in three days; but this mortar was cracked, and broke under a weight of 198 lbs. These experiments were made in the beginning of 1825.

Having communicated these results to Mr. Bergère, *chef de bataillon*, of the engineers, he informed me that Mr. Raucourt, engineer of roads and bridges, had published at Petersburg, in 1822, a memoir in which he mentioned the influence of air on the calcination of clays that are to be transformed into puzzalonas. I procured this work, and quote the following remarks from page 130. "I had thought for a long time that the degree of calcination could not be the only cause of the superior qualities that argillaceous earths acquire by a few minutes' torrefaction: if it were otherwise, slightly burned bricks would furnish excellent puzzalonas, which is far from being the case, and several essays made with pounded bricks, burnt with various degrees of intensity, gave me no result comparable to that given by clay exposed on a red hot plate.

"It was thence inferred that the contact of air is necessary to modify, in the most favorable manner, the oxides which the earths contain, so that they may form good hydraulic combinations with lime. To assure myself more completely, I made direct experiments which fully confirmed this induction, and which led me to more particular researches than had before been made on factitious hydraulic lime."

The experiments of table No. XVI show, in opposition to the opinion of Mr. Raucourt, that lightly burned bricks may furnish very good puzzalonas, when they contain lime, and the burning has been properly managed. This engineer asserts positively, in this quotation, the necessity of contact of air to modify the clays advantageously; but he reports none of the experiments that he announces as having made.

At page 135 of his memoir he says:

"If it be true, as is said, that the earths are metallic oxides, one might be led to think that they have need of a certain degree of burning in contact with the air, to form with lime, and the concurrence of water, insoluble compounds; and as several chemists have already shown that the presence of silex in the state of gelly will contribute to render a fat lime hydraulic, that it is the same with the oxides of iron and magnesia; that Mr. Vicat, by his transformations with clay, proves that alumine, also, might enjoy this property; that if the very hydraulic lime I H (Art. 163) be observed, it will be allowed that magnesia must necessarily fulfil analogous functions; one would be almost convinced that all the metallic oxides, properly prepared with fire, would form, with lime, combinations susceptible of hardening in water."

There are many errors in this passage; for it is demonstrated that iron and manganese act no part in hydraulic limes; and what Mr. Raucourt says in this particular, proves that he has not consulted experience. Nothing has proved, as yet, that alumine, or magnesia, possesses the property of forming hydraulic lime. (The lime cited art. 163, contains clay.) Lastly, nothing is more doubtful than such properties as Mr. Raucourt has attributed to almost all metallic oxides. In a matter so delicate as this, the imagination must not get in advance of facts.

As Mr. Raucourt has not given the experiments which led him to the opinion that the air acts an important part in perfecting artificial puzzalonas, I am obliged to draw my conclusions from the facts presented in my preceding table, and principally from the last four experiments reported in page 24. There are two things to consider in artificial puzzalona; the first, is the promptitude of induration of the mortars whereof they form part; the second, is the resistance of these mortars. The experiments at the end of table No. XX, the observations I made on Nos. 5 and 6, of table No. XXIV, and the few experiments cited in page 24, prove that when these clays are calcined in a current of air, they harden much the more promptly. But is the resistance of the mortars greater, also? I cannot affirm positively that it is.

We see, for example, in the four experiments cited, that the case of the most prompt hardening, coincides with the weakest resistance; but we ought not to conclude from thence, in a positive manner, that the calcination in a current of air diminishes the resistance at the same time that it increases the promptitude to harden; because the result obtained may have depended on some other cause—as, for instance, the degree of calcination. What induces me to think that calcination of clays in a current of air, far from diminishing the resistance of mortars, will, on the contrary, augment it, is, that all the clays Nos. 5 and 6, of table No. XXIV, having been heated in this manner, the hardening was very prompt, at the same time that the resistances were very great. I cannot positively affirm that this last effect will follow, but I think it probable. I have not had time to make the direct experiments that I intended, in order to clear up this point.

In a note printed by me in 1825, I stated that I was induced to think that at an elevated temperature, the alumine contained in clays absorbed oxygen, and that this absorption rendered cements more proper to combine with fat lime in the moist way. Mr. Vicat is of a different opinion. He inserted a note in the *Annales de Chimie*, of 1827, Vol. XXXIV, wherein he says that he calcined, for half an hour, pulverised clay in close vessels, and that he heated the same quantity, during five minutes, on a metallic plate kept at a common red heat. After cooling, the substances were weighed, and were found to weigh nearly the same. Mr. Vicat concludes from the small differences found between the weights of clays calcined in close vessels, and those calcined in the air, that there is, incontestably, no absorption.

I will remark, that nothing can be concluded from this experiment. A part of the clay was calcined during half an hour, and the other part during five minutes only; the quantities of water lost by these two portions could not, therefore, have been the same, since they were not equally heated. It is, besides, possible that a small quantity of oxygen, difficult to appreciate with a balance, might suffice to give new properties to the clay. To know whether alumine absorbs oxygen, it would be necessary to heat it highly in a tube not susceptible of oxidation, and to pass, during the calcination, at different times, a given volume of oxygen gas, over the incandescent alumine, and, afterward, to measure the volume of gas, in order to ascertain whether it had been diminished. I had not under my control the means necessary for making this experiment; the observation that I made, that alumine calcined in a current of air, dissolved more easily in sulphuric acid than when calcined in a close vessel, led me to think there was an absorption of oxygen, but it is no proof; I offer it as a presumption only.

Several Engineers have proclaimed the good results obtained with ashes derived from the combustion of coal in furnaces, or lime kilns; others on the contrary, have denied the effect of this substance. With this question, it is the same, I am satisfied, as with the question whether dust of tiles or bricks, much, or little burned, should be taken. The good results of the Tournay ashes* have been known for a long time, and are contested by no one. Having been employed at Lille, in 1815 and 1816, I had an opportunity of knowing the good effects. But when I wished to use, in the same way, the coal ashes at Strasburg, I could not obtain a good result. I made mortars composed of one part of fat lime measured in paste, and two parts of coal ashes: after an immersion of a year, these mortars were as soft as if made of sand. These opposite effects surprised me, and on examining different coals and their analyses, I saw that several of them contained quite a quantity of clay, while others contained little or none. But coals are generally burned on a grate: the clay they contain is thus calcined in a current of air; and it is the mixture of this clay with a little iron, constituting the residue, that is used, when we take these ashes: we see, therefore, that it is a real puzzalona that they have been making, for a long time, without knowing it. Should the coal contain no clay, or should the clay be mixed with too much lime; in the first case no result will be got; and in the second, if the calcination has been too high, the ashes will possess but an indifferent quality.

I think Mr. Sganzin is wrong when he says in his *cours de construction*, page 32, "Experience teaches that the ashes of all coals which have served for the calcination of lime, will form a mortar hardening promptly in water." We know that when lime is calcined with coal, the ashes of the combustible is mixed with a considerable quantity of particles of lime. Although the coal should contain no clay, if the lime calcined be very hydraulic, I conceive that a mortar of fat lime and these ashes would harden in water; but the result would be due to the presence of the hydraulic lime; I think that no result would be obtained if, with such coal, the calcination were of fat lime.

In 1826, I was charged with the inspection of several places along the Straits of Calais. Much coal is used in these departments. At Boulogne where the forts of the sea coast were to be repaired, I requested Capt. Le Marchand of the Engineers, to make some experiments with cements and the coal ashes of the neighbourhood, because the use of the Boulogne pebbles, before mentioned, was very expensive, and it was difficult to obtain them in quantity. This Engineer took great pains in his researches, and informed me that he had obtained good results with some cements, and especially with the ashes got from the coal burned in several manufactures in Boulogne. He procured the analysis of this coal, which is composed of the following substances; combustible matter, 96.62; alumine, 2.00; silex and iron, 1.38. Therefore the ashes he used were nothing else than a very aluminous clay, which contained no lime, and which had been calcined in a current of air during the combustion of the coal, and it is not astonishing that it gave very good mortar. The cinders of forges, another residue of the combustion of coal, may be assimilated to ashes: there are some that give very good, and others that yield no results: neither should, in any case,

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*Rondelet, in his *art de batie* thus describes this substance. "This powder is made of half burned fragments of a very hard blue lime-stone. These fragments fall, during the burning, through the grate of the lime kilns, and are mixed with the ashes of the coal. The Tournay ashes are considered equal to the Dutch trass, and are used for the same purposes." Tr.

be employed without our being assured of their quality. To know if they may be used with advantage, the practical process for distinguishing good cements from those that have no hydraulic property, that I will soon point out, should be followed.

I commenced my experiments on artificial puzzalonas in 1821; and the first operation I performed was to see whether I could make puzzalona and trass anew out of their constituents. I accordingly took the substances contained in trass and puzzalona, according to the old analysis which is given in Vol. XX, p. 391; with these I made a paste with water; afterward, I calcined the mixture at a low red heat for six hours; and, lastly, reduced it to very fine powder. As I had no natural alumine at my command, and as I doubted the efficacy of that to be obtained from the decomposition of alum, I took the Cologne pipe clay, washed it several times with a great deal of water, and decanted, to separate the greater part of the sand from the alumine. I assured myself, by calcining a small portion of this earth, and dissolving it in sulphuric acid, that it contained hardly any silex. This is the substance to which I added the other matters in the proportions given in the old analysis. We see then that, by this operation, my artificial trass and puzzalona had a little more silex than the natural productions, by the quantity retained in the aluminous earth; but this augmentation of silex was the same for both mixtures. I made two mortars by taking one part of Obernai lime, and two parts of each of these compounds: the mortar of the factitious trass hardened in four days, and broke under the weight of 385 lbs: that made of the artificial puzzalona hardened in three days and supported 477 lbs. before breaking. The lime was the same in both experiments: all other circumstances were alike: wherefore we must attribute the superiority of the artificial puzzalona over the artificial trass, to the clay of the first mixture containing much more alumine than the second. I was wrong in using hydraulic lime: I should have used fat lime, which I, afterward, always used when I wished to determine the quality of puzzalonas or other analagous substances. This experiment, and those which were made of the very aluminous clays of Frankfort and Cologne, prove that results, exactly like those furnished by natural puzzalona, are obtained, by suitably calcining greasy clays.

I was not able to determine the proportion in which the silex and alumine should exist to give the best results; but I am led to think that the alumine should equal, at least, a third of the silex. We have seen, however, that the Sufflenheim clay, which contains seven parts of silex to one of alumine, sometimes produced very good cements; but it is probable the best were obtained with portions of clays more aluminous than the others. The results contained in table No. XXII support this opinion. It is true we might be inclined to infer the contrary from the new analysis of trass and puzzalona made by Mr. Berthier, and given in Vol. XX, p. 391. The proportion of alumine is about the same in Trass and Puzzalona, according to Mr. Berthier, and is much smaller than according to the older analysis: but the analysis of a single specimen must not fix the proportions of a substance which gives, as we have seen, very various results; and every thing leads to the belief that the several pieces of trass and puzzalona vary much in their composition. It is possible that the specimens of trass and puzzalona that I sent to Mr. Berthier, were possessed of a high degree of energy, although containing but little alumine, by reason of the potash they contained; for this substance augments, in a sensible manner, the energy of puzzalonas, as we have seen in the experiments of table No. XXIII. But the good results obtained from the calcination of greasy clays, prove that cements without potash, may be made to be quite equal to trass and puzzalona.

The experiments above show that, with artificial puzzalona and fat lime I have obtained mortars much superior to those made with artificial, or even natural, hydraulic lime, and sand. Although I happened, with some pieces of Obernai lime, to obtain results approaching those afforded by artificial puzzalona, such instances are rare; and, in cases like these, it is the general bearing of the facts that we are to regard. I announced these results in a little pamphlet published in 1824, and I stated, moreover, that there would accrue a sensible economy. Mr. Vicat, in a criticism on this pamphlet has endeavoured to prove the contrary; but it will not be difficult to show that he was deceived in his calculations. This Engineer says "The objection of Mr. Treussart to the high price of artificial limes is without foundation. In fact the trass mortars are as follows:

| | |
|---|---|
| For two cubic metres of trass (70.68 cub. feet) *a* $5.22½ . | $10.45 |
| For one cub. metre (35.34 cub. ft.) of fat lime in paste . . | 2.28 |
| | $12..73 |

"The three cubic metres of materials are reduced by the mixture to 2.30m; it follows that the cubic metre costs $5.53 (35.34 cub. ft. cost $5.53 equal $0.16 per cub. foot.)

| | |
|---|---|
| On the other hand to make a cubic metre of hydraulic lime mortar, requires 0.90m of common sand *a* $0.28½ | $0.26 |
| 0.43m of hydraulic lime in stiff paste, which at the mean price will cost (one foot cost $0.34) . . | 5.27 |
| | $5.53 |

The prices then will be exactly the same, since in each case it is found to be $5.53: but let us see it the basis of this calculation is exact. I will first remark, what I did not neglect to state in my pamphlet of 1824, namely that the mortars of fat lime, sand and trass, gave me results which were often superior to those in which there was trass without sand; and that it was the same with mortars made of puzzalona. We may satisfy ourselves by table No. XIII that when the mortars of trass and puzzalona, alone, were superior to those containing sand, the advantage was not sufficient to lead to a preference of the former. I obtained a like result with artificial puzzalona of table No. XXIV. It is, therefore, an error of Mr. Vicat's to compare the price of mortars made of artificial hydraulic lime, with that made of fat lime and trass without sand: it is necessary to compare it with mortar made of lime, sand and trass. If the first calculation, above, be thus rectified, the price of $10.45, given by two cubic metres of trass at $5.22½, will be reduced to $5.51, resulting from one cub. metre of sand at $0.28½, and one cub. metre of trass at $5.22½: consequently the cubic metre of mortar composed of fat lime, sand and trass, will amount to $3.39=$0.10 per cub. foot, only, instead of $5.53. The objection that I made, therefore, is not, as Mr. Vicat thought, without foundation. I feel bound to state that the prices I have given, using the data established by Mr. Vicat, appear to me to be too low for the principal places in France; but I was obliged to use the elements he had employed.

It is possible that in countries where chalk is abundant it will not cost more to make hydraulic mortar with artificial hydraulic lime and sand, than with fat lime, sand and factitious trass: but in many countries chalk is not to be procured; and then it will be necessary to mix fat lime with clay, and to give a second burning for the mixtures; which will cause embarrassment, and an augmentation of expense. I am convinced that, in such cases, there will generally be economy in making hydraulic mortar at once of fat lime, sand and artificial trass: and besides the relation of the resistance of these two kinds of mortar, is no important consideration. If we compare the results obtained in all the preceding tables, we shall see that the mortars made of sand and hydraulic lime, whether natural or artificial, afford an average resistance hardly amounting to 220 lbs., while it is 352 lbs. for the mortars made of fat lime, sand and natural or artificial trass. To compare the expense justly, therefore, it would be necessary to lessen the preparation of trass, substituting sand, until we arrived at an equal resistance.

I must, besides, observe that we are much more certain to obtain uniform results with hydraulic mortars, composed of fat lime, sand and factitious trass, than with those that can be made of artificial, or natural hydraulic lime, and sand only. We have seen, in fact, that hydraulic limes deteriorate when a little too highly calcined; it is necessary to keep them carefully from the rain; and they, in general, lose a great part of their hydraulic property, unless used soon after leaving the kiln; which often occasions embarrassment. With fat lime and factitious trass, all these difficulties are avoided; because the lime loses nothing by being a little more calcined than necessary. It is not necessary to use it immediately, nor to take any troublesome precautions. As to factitious trass, once prepared, it needs no particular care: for neither the influence of the air, nor humidity, will deprive it of any of its properties.

It results from what I have said that, in a country where there are good natural hydraulic limes, they should be used in preference to fat lime, which requires, always, to be mixed with natural or artificial trass, for constructions in water or in damp places. There will be economy, and no bad results to fear, in taking the precautions I have pointed out. When, however, works demanding great care, are to be made, such as floors of Locks, caps of Arches, &c., I think it will be proper to add to the mortar a little natural or artificial trass. The proportion to be added depends on the quality of the hydraulic lime and of the trass. If both are of good quality, and if it be known, for example, that the lime will bear two and a half parts of sand, then the mortar may be composed of one part of this lime, two parts of sand, and half a part of factitious trass. This small quantity of trass will not much augment the expense, and will always correct the bad effects resulting from portions of the lime having been too much burned, or impaired by exposure to the air. The further the hydraulic limes are from the qualities I have above supposed, the greater should be the proportions of natural or artificial trass.

The question, however, is, to know what should be done in a country where there is no hydraulic lime, or where it is of an inferior quality. It is on this point that I differ entirely from Mr. Vicat. This engineer contends that it is best to make factitious hydraulic cement by the process he points out; while I think there will, in general, be more economy, and better and more uniform results, by making hydraulic mortars at once from fat lime, sand, and artificial trass. It appears to me that the general bearing of the very numerous experiments I have presented, leaves no room to doubt as to this matter.

I will add, that, from time immemorial, in countries affording natural hydraulic limes, they have been used with great advantage. Wherever they were not to be had, hydraulic mortars were made, directly, of fat lime and cement. I have, several times, had occasion to demolish works in water, of which the mortars had been made in this manner. It appears then, that, in fact, I only propose to continue a method long in use, with this difference, that in lieu of using every kind of cement indiscriminately, I give the means of distinguishing the good from the bad, and of making such as will give results equal to those furnished by natural puzzalona or trass.

To ascertain which are proper cements to produce good hydraulic mortars, on being mixed with fat lime, the following means may be used. From a neighbouring brick kiln three bricks should be taken, one of which should be a lightly burned brick; another should be chosen from those which are considered to be burned in the best manner; and a third from those too much burned, but not vitrified in any degree. The brickmakers know well how to distinguish them by the sound and the colour. A fragment of each of these bricks should be separately reduced to a very fine powder, and passed through a very fine wire seive. The finer the dust, the better; in taking it between the fingers no grains should be felt, and it should be soft to the touch. Fat lime which has been reduced to paste for some time, should then be made into mortar with one of these cements—using one part of lime in paste, to two parts of cement. They must be well mixed together, adding the water, necessary to produce a pasty state. The mortar should then be placed in the bottom of a tumbler. If the mortar be stiff, the tumbler may at once be filled with water; if, on the other hand, the mortar has been made rather thin (which facilitates the mixing) it should be left long enough in the air to assume some consistence before the glass be filled. The same course should be followed with the two other cements, and all the glasses must be ticketed. It is necessary to add, in making the several mortars, such quantities of water as will bring all to the same consistence, nearly. After two or three days, the mortars should be touched lightly with the fingers, to ascertain whether they have begun to harden; and when this happens, they must be examined every day, noting that which hardens first, and the time at which each arrived at that degree of induration that on pressing it strongly with the thumb no impression was made. In order to judge more accurately of this state, the turbid water must be thrown off, and the surface of the mortar, which is always covered with a little semi-fluid matter, must be lightly cleaned with a rag. If the mortar is not yet hard enough to resist the thumb when strongly pressed, it must be again covered with water for subsequent examination. Should there be several brick yards at hand, using different clays, the same process should be applied to the brick dust from each. It will be useless to try dust from tiles, provided the clay is the same as that used for bricks, because the result would be substantially the same.

We have seen that the dust of bricks which have been burned in a current of air, hardened in the space of three or four days, while the dust of bricks burned out of a current of air, has generally taken from ten to twenty days, and sometimes even thirty days to harden, and has, nevertheless, made good mortars. I have also made the remark, that mortars of the hydraulic limes which harden very quickly, did not give great resistances; but those made of cements which have caused fat lime to harden promptly, have always given good mortars. We ought, therefore, to prefer those cements which cause fat lime to harden promptly. If any cement, after fifteen or twenty days, gives to fat lime only a weak consistence, it should not be employed.

In experimenting with the ashes and cinders of forges, the same process should be followed. If, of these substances, after a month's immersion, any should impart to fat lime but a feeble consistence, or remain entirely soft—in neither case should it be employed.

By means of a very simple chemical process, it may be ascertained before hand, whether bricks but little, or highly, burned, should be taken. Take a little of the crude clay, or a little of the brick dust, put it in a glass and pour over it a little diluted nitric or muriatic acid, or even strong vinegar; should there be no effervescence, it is proof that the bricks should be highly calcined to give good cement. Should there be considerable effervescence, it is because the clay contains a notable quantity of carbonate of lime. To determine nearly the quantity of lime, a little of the clay, having been dried in a gentle heat, must be weighed; it must then be diffused through a small quantity of water, and muriatic acid be poured on, little by little, as long as there is any effervescence; it should then be filtered, or gently decanted, the residue washed in a large quantity of water and again decanted. The residue being then dried in the same gentle heat as at first, must be again weighed; if the weight be less by one tenth, than at first, it is a proof that the clay contained that quantity, about, of carbonate of lime, which has been dissolved out by the acid. In this case bricks but lightly burned must be taken; and so much the less burned as the loss of the clay, by the acid, shall have been the greater. If the clay lose only four or five per cent. of its weight, the bricks which are called "well burned bricks," should be preferred. In addition to the chemical trial just described, it will always be proper to make the trial first explained—that being the most certain.

With brick dust, we may easily obtain mortars which, according to my mode of determining tenacity, will support from 220 lbs. to 330 lbs. before breaking, if composed of equal parts of lime, sand and brick dust. This force is sufficient for gross masonry: but, for important works, such as the floors of locks, foundations of dikes and dams, caps of arches, and for factitious stones, of which I shall speak in the sequel, it is necessary to have cements that will give mortars capable of supporting from 330 lbs. to 440 lbs.

To obtain cements or puzzalonas of the strength just mentioned, we proceed in the following manner. We choose clays soft to the touch, taking, in preference, those of which earthen ware, stone ware, delft ware and tobacco pipes are made, ascertaining, by the above chemical trials, whether there be any lime, and if so, the quantity. Of these clays we make balls of the size of an egg, which we calcine in a reverberatory furnace, heating gently at first, and, after about one hour, pushing the fire so as to keep the balls constantly at a low red heat; the balls, of which there will be ten or twelve, being placed within a large Hessian crucible having a hole in its bottom. To avoid exposing these clays to be struck by a current of cold air, as they would be if put on the bottom of the crucible, a piece of slate perforated with many small holes should be put across the middle of the crucible, (which is commonly of a conical form, narrowest at the bottom:) by this means the balls of clay will be in the centre of heat, and will be, during the calcination, always in contact with a current of atmospheric air. When the balls have been burned for three or four hours, according to the quantity of lime contained in them, one of these balls will be taken out, and marked with the number of hours it has been under calcination; at the end of every succeeding hour another ball will be withdrawn and marked in like manner. All the balls being withdrawn, they will be reduced to fine powder, and a mortar will be made of each, exactly in the same way as was pointed out for mortars made of brick dust. We shall ascertain, in this way, the time of burning required by the clay, to give to fat lime the most prompt induration, and we shall have an idea of the difficulty to be overcome in reducing the cement to powder. To operate on a large scale proceed as follows.

In countries where wood only is to be burned, a furnace may be made like that in the plate I, Fig. 2. If the clay to be used be greasy, the expense of tempering it may be saved. It will be cut from the bank into pieces, of the form and dimensions of common bricks. These will be dried in the air like bricks, and then be placed on their edges on the hearth of the furnace, laying them obliquely with respect to its axis, and at a little distance asunder; the second layer will be placed on the first, crossing them. A fire will then be made in the two arches below the hearth, gentle at first, and gradually increased. It is apparent that the clay will, in this way, be calcined in a current of air, through the holes in the hearth. These bricks will be heated less intensely than the balls that were in the reverberatory furnace, and it will therefore be requisite to leave them exposed to the fire for a longer period. After twelve or eighteen hours calcination, one brick will be withdrawn. If the clay is coloured with iron, the colour will now be compared with the colour of that specimen of the first trial which gave the most prompt induration to fat lime. If the colours are exactly alike, it is a proof that the clays in the furnace have received sufficient calcination, and the fire will be stopped; but if the colours are different, the heat will be continued, and another comparison will be made, after another lapse of time; and so on until a colour is obtained which indicates the proper degree of burning.

If the clay contain little or no iron, or if the furnace trial showed that the colour varied but little with considerable variations in the intensity of heat, then, having withdrawn, successively, several bricks, reduce them to fine powder, and make several mortars by mixing this powder with fat lime—noting the time required to harden, and taking all the precautions directed for the proof essay. In the first batches burned on a large scale, considerable pains will undoubtedly be required to determine the time requisite for the best degree of calcination; but when this point is once ascertained, there will be no longer any difficulty, and the operation may be confided to ordinary workmen.

In countries where the fuel must be coal or peat, it will be preferable to use a conical kiln for burning the clay. I will observe here, that Mr. Chaptal in calcining the clays of the south, in a conical kiln, placed them, by accident it appears, in the most advantageous position; that is to say, they were so placed as to cause them to be calcined in a current of atmospheric air. If this celebrated chemist had noticed the great action that lime exercises on the calcination of clays; and that it is necessary to heat but little when the clay contains as much as one tenth, and to heat much when it contains little or no lime; he would have completely resolved the important question of the perfection of artificial puzzalonas. In many of the northern Departments, conical furnaces are used for burning lime. Plate I, Fig. 3, represents one of those furnaces which I saw in the neighborhood of Paris. The following is the mode to be adapted in burning clays therein. Instead of the form of bricks, the clay will be cut from the bank with a shovel, into nearly cubical pieces. A workman will then with his hands, flatten the angles, giving to each piece a rounded form of the size of an apple, which will not require much labour. These balls will be left to dry in the air. Preparatory to placing the balls in the kiln, an arch of dry stone masonry, will be turned from the centre pier to the sides of the kiln, at the height of the top of the four doors. The centre pier serves, besides, to direct the contents of the kiln towards the doors. The dry stone arch will be so constructed as to leave passages for the air. A rather thick layer of coal or turf will be put upon the arch, and on this a layer of balls of clay, thus filling the kiln with successive layers of fuel and balls of clay. When the kiln is two-thirds full, the arches will be filled with fuel. The fire being lighted at the four openings, will gain the whole interior of the kiln, and the clays will be thus calcined in a current of air. After some time—demolishing a portion of the dry stone arch, a few balls of clay will be withdrawn, with which the different essays that I have pointed out, in speaking of the other furnace, will be made. The dry stone arch will permit the fuel to be renewed under the clay, until the balls of clay near the bottom, and which are the least burned, have received the requisite calcination. In proportion as the combustible is consumed, the mass of balls of clay will subside, and new layers of balls and of fuel will be supplied above. When the trials have shown the clay below to be sufficiently burned, the arch will be taken out. The lower balls will fall towards the openings, and will be removed with tongs. The others will descend, also, as the fuel burns away. As fast as clay is withdrawn from below, fuel and clay will be added above, so as to make the burning continual. If some balls are found not sufficiently burned, they will be put aside, and when enough are collected, will be reburned by being mixed with less fuel. A kiln built expressly for making puzzalona, might be of smaller dimensions than that represented in Fig. 3. Perhaps two openings would suffice; replacing in this case the pier in the middle by a wall of the same height, sloping both ways, and presenting an arch towards each of the openings.* This kind of kiln would be of great advantage in the calcination of hydraulic lime, as it would supply fresh quick lime during all the season of operation—an important object, as we have seen by preceding experiments. There would also be a more uniform burning than in the kilns ordinarily constructed in Alsace, where the lime is burned in a very unequal manner. I am persuaded that in places where coal can be procured at a moderate price, great advantages may be derived from conical furnaces; which will serve, at the same time, for the calcination of hydraulic lime, and of clays of which it is designed to make artificial puzzalona.

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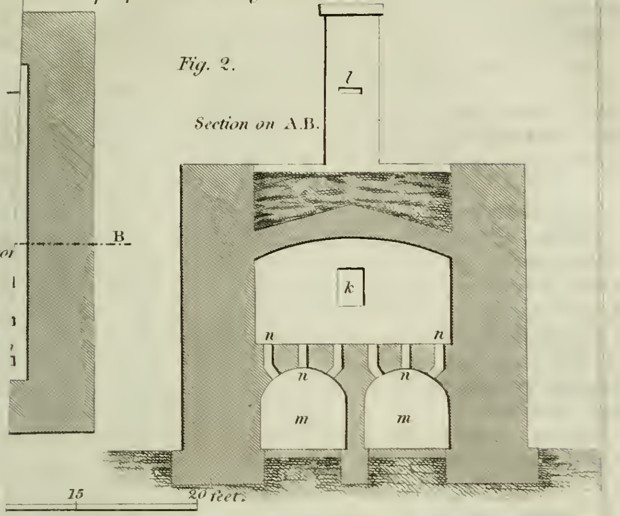
* In situations where calcined clay is hard to pulverize, and there is no machinery to apply to this object, the crude clay should be dried in the air, and being reduced to powder, should be burned in a reverberatory furnace of which the hearth is laid at the greatest angle that the clay dust will lie without sliding. On this inclined hearth a layer of dry powder will be placed of the thickness of six to eight inches. The front of the furnace should have a horizontal portion, on which to make a fire of wood. The inclination of the hearth will cause the heat and flame in passing upward towards a chimney in the part opposite to the fire, to heat the powdered clay. From time to time, the heat will be suspended in order to stir the clay with a rake. In this way it will be calcined in a current of air, and the operation of pulverising the cement, which is both tedious and expensive, when there is at command no proper machinery worked by water, will be avoided. Au.

Jour. Frank. In

d at Strasburg in calcining clay in a
for the purpose of making Alum.

Fig. 2.

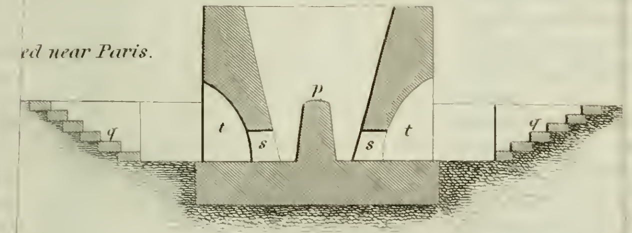
Section on A.B.

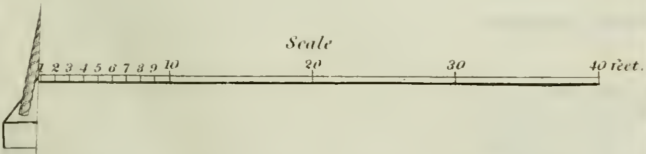


3.

Section on C.D.

ed near Paris.





Engraved by J. Yeager.

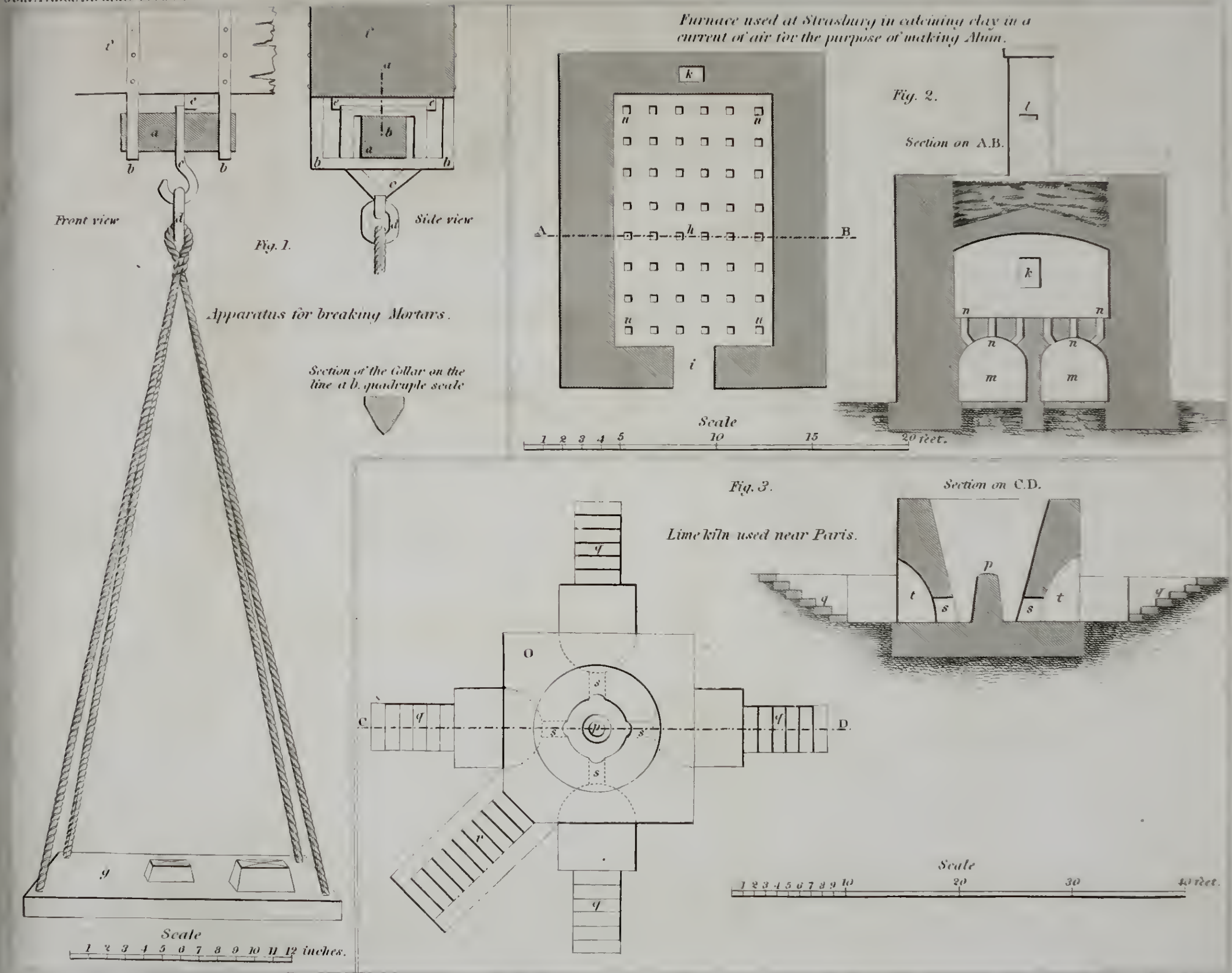


Fig. 1.

Apparatus for breaking Mortars.

Section of the Collar on the line a b. quadruple scale

Fig. 2.

Furnace used at Strasburg in calcining clay in a current of air for the purpose of making Alum.

Section on A.B.

Fig. 3.

Lime kiln used near Paris.

Section on C.D.

In countries where there is neither coal nor turf, it seems to me that the conical furnace might still be used for calcining clays. It will suffice to take dry wood, and in preference round sticks, which should be cut into lengths of four inches: these little pieces should be mixed with the clay balls, and the operation of burning should be like that with coal. I do not doubt that a good result would be obtained.

Clays which are greasy to the touch are easily formed into balls, or shaped like bricks, without any preparation; but it is possible, it may be necessary to temper such clay as is used in brick making, this being generally more meagre.

When very greasy clays, containing no lime, are used, it will sometimes be difficult to reduce the cement to powder without machinery. In such cases, clays should be preferred which are not too greasy and which contain about five per cent. of lime: these clays are, moreover, more common than others. It is not to give energy to the cements that we should prefer earths containing a little lime: we have seen that opposite effects are sometimes produced. But the presence of this substance has two considerable advantages; the first is that the clay requires less burning to yield good puzzalona, whence results an economy as to the fuel: the second is that the clay containing lime is more easily reduced to powder. Thus it might be well to mix a little lime with clays which contain none, or to mix clays which contain no lime with clays that contain too much: but as these operations require a good deal of work, it will be necessary to calculate the relative expense of the several modes, namely, burning the clays hard, and pulverizing them, though with difficulty—mixing a little lime with the clay—or mixing clays together. The relative expense will depend on the price of fuel, and the means at command for breaking down the clay. A pestle mill, or mill with large stones, like those used in pulverizing plaster of Paris, would, it appears to me, be most convenient.

The name *puzzalona* expresses that this substance is obtained from the village of Pouzzol in Italy—that of *trass*, has no etymology. In the notice which I published in 1825, I proposed to give the name hydraulic cements to substances substituted for trass and puzzalona. This denomination appears to me to be convenient, and I shall generally employ it. I have entered into many details as to the fabrication of these productions because they are of great importance in constructions. I proceed to report sundry experiments that I made with hydraulic mortars.

[TO BE CONTINUED.]

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## Physical Science.

### *Speculations respecting Electro Magnetic Propelling Machinery.*

By the Editor.

In our number for November last, Vol. XX, p. 340, we published the specification of Mr. Davenport's patent for a machine intended to furnish a motive power by the agency of Electro Magnetism, to which we appended some remarks upon the subject generally. We had hoped, ere now, to have received more definitive information than has transpired, respecting the progress of the experiments which are being made in New York with a view to its testing the utility by applying it to drive a Napier Press, requiring a two horse power; we have hitherto learnt nothing of the result, of this proposed experiment; and suppose, therefore, that the trial has not yet been made.

Since publishing the article above alluded to, it has appeared to us that should a much less power be attained by such a machine than that which is now sought for, say the power of a man only, it would still be equally valuable with the steam engine, and would produce as great, if not a greater change, in the economy of the useful arts, as has been produced by that instrument; this, however, is under the proviso that the cost of materials consumed in performing the work of a day should be less than that given for the labour of a man. Who is there who would not under such circumstances, need such a machine? If we hire a man by the day we must not allow him to be idle, as in that case we give our money for nothing. The current of his life flows on, and he must be fed and clothed or the stream will stop. But give us a machine which is not costly at first, and which if it works but one hour in the twenty-four, will itself be a consumer in that proportion only; a machine which we can at any moment set to turn our lathes, our grindstones, our washing machines, our churns, our circular saws, and a catalogue of other things which it would be no easy task to make out; such a machine would also perform a million of other operations by the conversion of the rotary into a reciprocating motion; and we again ask who is there among us who would not want one? our farmers, our mechanics, and our housekeepers generally, must all be supplied. We could no more submit to live without it, after it has been once introduced, than we can now submit to travel at the slow rate of ten miles an hour, an event which we have learnt to think one of the miseries of human life.

With such a machine at our command we should soon wonder how we could have lived so long without it; and if taken from us it would leave a most awful chasm in the necessaries of life, of the existence of which our fathers never dreamed, and which happily we could not be called upon to witness so long as the store house of nature would enable us to obtain zinc and sulphuric acid at a cheap rate.

The steam engine cannot be used to advantage where it has not the labour of several horses to perform, as, whether large or small, it requires the constant attention of the engineer, or of the fireman, and is kept at work at an expense which is relatively increased as its power is diminished. One giving the power of a man only would be employed, at a cost which would pay the hire of two or three men, and if used but for an hour or two in the day, the expense would be incalculably increased; of course it is not, and never will be used, under such circumstances.

Let it not be said that we are prophesying about what is to happen; not so by any means; but be it remembered that we are speaking of what is a possible contingency. We have no doubt respecting the practicability of obtaining the power of a man by the agency of electro magnetism; we believe that such a machine may be kept at work without any considerable tax upon the time of the person using it, and we further believe that the only thing which can prevent its coming into use is, the cost of the materials employed in operating it; the statements which we have heard upon this point are extremely contradictory, and upon the whole, are far from encouraging; the time, however, is not remote when this point will be determined.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

## *Reduction of observations of the Solar Eclipse of July 26th and 27th*, 1832.

### By E. Otis Kendall.

This Eclipse was observed at several places in Europe and America, as follows:

| No. | Place of observation. | Latitude. | Phase obs'vd. | Mean time of observation. | | | | Observer. |
|---|---|---|---|---|---|---|---|---|
| | | | | d | h | m | s | |
| 1 | St. Croix. | +17° 44′ 32″ | Begin. | 26 | 19 | 11 | 52.80 | Andrew Lang. |
| 2 | | | End. | | 21 | 34 | 16.30 | |
| 3 | Phila. 0.12s. E. of | +39 56 59 | Begin. | | 18 | 54 | 46.20 | S. C. Walker. |
| 4 | State House. | | End. | | 20 | 39 | 20.20 | |
| 5 | Phila. 0.7s. W. of | | Begin. | | 18 | 54 | 54.60 | Wm. Mason. |
| 6 | State House. | | End. | | 20 | 39 | 13.40 | |
| 7 | Warminster Pa. | +40 8 | End. | | 20 | 39 | 8.30 | E. W. Bean. |
| 8 | Albany, | +42 39 3 | Begin. | | 19 | 7 | 2.50 | Prof. Alexander. |
| 9 | | | End. | | 20 | 45 | 45.50 | Cerquero. |
| 10 | San Fernando, | +36 27 43.5 | Begin. | 27 | 1 | 3 | 31.50 | Sanchez. |
| 11 | | | End. | | 3 | 9 | 4.75 | Montojo. |
| 12 | Marseilles, | +43 17 50.1 | Begin. | | 2 | 23 | 37.43 | Gambart. |
| 13 | | | End. | | 3 | 35 | 35.21 | |
| 14 | Padua, | +45 24 2 | Begin. | | 3 | 11 | 33.70 | Santini. |
| 15 | | | End. | | 3 | 47 | 10.80 | |
| 16 | St. Helena, | −15 55 26 | Begin. | | 2 | 33 | 44.00 | Johnson. |
| 17 | | | End. | | 3 | 32 | 24.30 | Armstrong. |

It therefore furnishes a good opportunity for determining the longitudes of several places in this country by comparison with corresponding European Observations.

The Sun's and Moon's places in the Berlin Jahrbuch for that date, were used in computing the following Elements and Co-ordinates with the logarithms of their variation in a mean solar hour, according to the method of Bessel, (Ast. Nacht. No. 321.)

| | | log. Hourly Variation. | | log .Hourly Variation. |
|---|---|---|---|---|
| T | 1h 20m | | 2h 20m | |
| $\sigma$ | 9h 40m 43.64s | | 10h 40m 53.50s | |
| $x$ | −0.893492 | | −0.315999 | |
| $y$ | +0.221782 | | +0.139504 | |
| $a$ | +126° 43′ 23″.23 | +2.1534 | +126° 45′ 45″.60 | +2.1534 |
| $l.\cos. d$ | +9.975198 | +5.3901 | +9.975222 | +5.3892 |
| $l.\sin. d$ | +9.516584 | −6.3063 | +9.516382 | −6.3070 |
| $l$ | +0.530935 | +5.8290 | +0.530989 | +5.6232 |
| N | + 98° 5′ 44″.77 | +1.6658 | + 98° 7′ 23″.09 | +1.7203 |
| $l.\frac{s}{n}$ | +3.790347 | +5.6580 | +3.790430 | +5.5472 |
| $l.h$ | +0.225087 | | +0.225209 | |

| | | log. Hourly Variation. |
|---|---|---|
| T | 3h 20m | |
| $\sigma$ | 11h 41m 3.35s | |
| $x$ | +0.261358 | |
| $y$ | +0.056945 | |
| $a$ | +126° 48′ 7.95″ | +2.1533 |
| $l.$ cos. $d$ | +9.975247 | +5.3892 |
| $l.$ sin. $d$ | +9.516179 | +6.3075 |
| $l$ | +0.531019 | +5.1833 |
| N | + 98° 9′ 4.09″ | +1.6810 |
| $l.\frac{s}{n}$ | +3.790502 | +5.5916 |
| $l.\ h$ | +0.225324 | |

Using these Co-ordinates and Elements I have deduced, by Bessel's formulæ, in the paper above referred to, the following co-efficients of $\varepsilon$ $\zeta$ and $\eta$,

| No. | *m* | *a* | *b* | *c* | *d* |
|---|---|---|---|---|---|
| | h m s | | | | h m s |
| 1 | —4 18 28.188 | +1.679 | —0.086 | +1.681 | —4 18 50.915 |
| 2 | —4 18 27.047 | +1.680 | +0.453 | —1.740 | —4 18 38.740 |
| 3 | —5 0 12.377 | +1.679 | +1.446 | +2.215 | —5 0 40.278 |
| 4 | —5 0 27.144 | +1.680 | —0.970 | —1.940 | —5 0 35.085 |
| 5 | —5 0 4.003 | +1.679 | +1.444 | +2.215 | —5 0 31.902 |
| 6 | —5 0 32.185 | +1.680 | —0.971 | —1.940 | —5 0 40.125 |
| 7 | —5 0 32.963 | +1.680 | —0.985 | —1.947 | —5 0 40.852 |
| 8 | —4 54 21.852 | +1.679 | +1.675 | +2.371 | —4 54 50.797 |
| 9 | —4 54 44.768 | +1.680 | —1.180 | —2.053 | —4 54 51.859 |
| 10 | —0 24 27.767 | +1.680 | +0.832 | +1.875 | —0 24 53.144 |
| 11 | —0 24 37.785 | +1.680 | —1.557 | —2.291 | —0 24 43.224 |
| 12 | +0 22 3.752 | +1.680 | +2.044 | +2.646 | +0 21 33,040 |
| 13 | +0 21 15.630 | +1.680 | —3.754 | —4.113 | +0 21 21.371 |
| 14 | +0 48 19.213 | +1.680 | +3.848 | +4.201 | +0 47 39.111 |
| 15 | +0 46 40.356 | +1.680 | -10.024 | -10.164 | +0 47 21.045 |
| 16 | —0 21 44.566 | +1.680 | —7.827 | +8·005 | —0 22 13.294 |
| 17 | —0 22 27.846 | +1.681 | —2.440 | —2.962 | —0 22 39.423 |

Where

$m$ = the Longitude + East, — West from Greenwich which would result from these observations, if the places of the Sun and Moon as given in the Berlin Jahrbuch were free from error.

Making

$\varepsilon$ = the correction of the tabular place of the Moon in its orbit, in seconds of space.

$\zeta$ = the number of seconds of space by which the Moon is farther north or south than its tabular place.

$\eta$ = the correction of the sum of the tabular semi-diameters of the Sun and Moon in seconds of space.

$d$ = the longitude from Greenwich resulting from the application of these corrections as far as determined, then by Bessel's formulæ,

$$(A) \ldots\ldots d = m + a\,\varepsilon + b\,\zeta + c\,\eta$$

From the above equations the most probable values of $\zeta$ and $\eta$ have been determined by Gauss', method of least squares and are as follows, $\zeta = -2''.1350$, $\eta = -3''.5622$. With these values of $\zeta$ and $\eta$, and their co-efficients $b$ and $c$ above, the values of $\varepsilon$ have been obtained by adopting for the longitudes of San-Fernando, Marseilles and Padua, those contained in the Nautical Almanac for 1838.

| No. | Place. | Phase. | $\varepsilon$ | Mean of Beginning and End. |
|---|---|---|---|---|
| 10 | San Fernando. | Beginning. | $-7''.668$ | $-10''.617$ |
| 11 | | End. | $-13\ .567$ | |
| 12 | Marseilles. | Beginning. | $-12\ .478$ | $-9\ .005$ |
| 13 | | End. | $-5\ .532$ | |
| 14 | Padua. | Beginning. | $-15\ .973$ | $-10\ .596$ |
| 15 | | End. | $-5\ .219$ | |

Mean of all the values of $\varepsilon = -10''.073$.

$$\text{Thus we have } \varepsilon = -10''.073$$
$$\zeta = -2\ .135$$
$$\eta = -3\ .562$$

These values in the equations (A) furnish for $d$ the results found in the third table, which are the most probable longitudes of the places of observation as derived from this eclipse. The longitudes deduced from the American observations are here repeated.

| | h. | m. | s. |
|---|---|---|---|
| St. Croix, A. Lang's Observatory W. of Greenwich, | 4 | 18 | 44.83 |
| Phila. State House, by S. C. Walker's Observation W. of " | 5 | 0 | 37.80 |
| " " Wm. Mason's " " " | 5 | 0 | 35.31 |
| Warminster, Bucks county, Pa. by E. W. Bean's " " | 5 | 0 | 40.85 |
| Albany Academy, by Prof. Alexander's " " " | 4 | 54 | 51.33 |

In making the above computations, the ellipticity of the earth was assumed to be 0.00324.

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

## *Simultaneous Meteorological Observations.* By John W. Draper, M. D.

*Prof. of Chem. in Hampden Sydney College, Virginia.*

The importance of the subject of meteorology, is at last beginning to be understood and felt by the scientific world; and in many parts of the United States private individuals have commenced keeping journals for the express purpose of aiding for the development of the laws, regulating the atmospherical phenomena. These journals, however, insulatidly considered, are of but little service; it is only when they stand in comparison with other similar papers containing observations made simultaneously at distant points, that their true value becomes apparent.

The faculty of Hampden Sydney College, Virginia, considering how desirable it was to organize a corps of efficient observers throughout the State, in case any thing should be done by Congress to provide the means for making this kind of observations, resolved, that in addition to the usual college duties of the senior class, they would hereafter require of them to keep a meteorological journal, containing at least three observations each day, Sunday excepted, of the barometer, thermometer, wind, and general observations, and the dew point once at least. On the plan going into operation, a number of individuals of the junior class volunteered their services; classes were arranged for each kind of observations and the general supervision given to the professor of Natural Philosophy.

It is highly desirable that similar arrangements should be made in every College in the United States. At Hampden Sydney the plan has been found to work without difficulty, and the hours of observation, having been judiciously arranged with reference to other College duties, the young men have little or no extra trouble. Colleges are the natural depositories of this kind of information—and as most of them, perhaps all, possess the requisite instruments, these operations can be conducted with extraordinary facilities;—Nor does the advantage end there, for an extensive class of able observers is gradually disseminated through the state.

I send herewith the result of the observations of the senior and junior classes, for the last month, to be disposed of as may appear best, and if published I hope it may draw the attention of other Colleges, in other States, to the subject. In this State, I have reason to believe it will be the cause of a systematic series of operations.

*Meteorological Observations for Nov.* 1837, *Hampden Sydney College, Va.*

| | Therm. | | | Min. | Barom. | | | Annex'd Therm. | Dew point. | Wind. | General remarks. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 7 | 56 | 65 | 61 | | 29.64 | 29.49 | 29.58 | 64.84 | 40 | SW. NW. N. | |
| 8 | 36 | 52 | 54 | 34 | 29.90 | 29.95 | 29.95 | 56.62.62 | 46½ | NW. NW. E. | |
| 9 | 42 | 60 | 60 | 30 | 29.93 | 29.92 | 29.80 | 53.60.60 | 37 | SW. W. W. | |
| 10 | 56 | 62 | 60 | 52½ | 29.79 | 29.78 | 29.68 | 59.60.62 | 58 | SW. SW. NE. | Rain till 12 o'clock. |
| 11 | 50 | 56 | 56 | 41 | 29.66 | 29.63 | 29.53 | 58.61.62 | 57 | | Fog. all day. |
| 12 | | | | | | | | | | | |
| 13 | 50 | 52 | 48 | 41 | 29.37 | 29.40 | 29.37 | 63.63.61 | 51 | NE, NE. NE. | Rained from 8. A. M. all day. |
| 14 | 40 | | 48 | 38 | 29-32 | 29.35 | 29.41 | 55 56.56 | 39 | NW. NW. N. | Cloudy till 12. |
| 15 | 35 | 56 | 48 | 25 | 29.61 | 29.64 | 29.65 | 51.53.54 | 42½ | NW. SW. SW. | Aurora seen this evening. |
| 16 | 30 | 50 | 50 | 24 | 29.75 | 29.83 | 29.84 | 47,53.53 | 37 | W. N. NE. | |
| 17 | 34 | 48 | 50 | 25 | 29.96 | 29.99 | 99.97 | 47.57.57 | 41½ | SW. W. SW. | |
| 18 | 38 | | | 32 | 29.88 | 29.84 | 29.77 | 50.56.58 | 43½ | SW. SW. SW. | |
| 19 | | | | | | | | | | | |
| 20 | 52 | 66 | 68 | 41 | 29.76 | 27.78 | 29.74 | 62.69 | 55 | SW. SW. SW. | |
| 21 | 48 | 66 | 67 | | 29.66 | 29.63 | 29.55 | 70.67 | 55 | SW. SW. SW. | |
| 22 | 55 | 67 | 68 | 51 | 29.20 | 29.00 | 28-78 | 69.70.71 | 58 | SW. SW. SW. | Storm from SW. P. M. commencing 4½. till 9 P. M. |
| 23 | 30 | 35 | 36 | 28 | 28.97 | 29.03 | 29.04 | 55.51.54 | 19 | NW. W. W. | |
| 24 | 29 | 38 | 35 | 25 | 28.99 | 29.04 | 29.03 | 39.51.46 | 18 | W. NW. W. | Cloudy. |
| 25 | 23 | 32 | 23 | 19½ | 29.39 | 29.23 | 29.23 | 35.45.42 | 32½ | SW. SW. W. | |
| 26 | | | | | | | | | | | |
| 27 | 26 | 43 | 46 | 7 | 29.73 | 29.87 | 29.87 | 33,49.49 | 31 | SE. SE. S. | |
| 28 | 37 | 51 | 53 | 30 | 29.95 | 29.99 | 29.95 | 43.47.49 | 41 | NW. W. W. | |
| 29 | 43 | 60 | 63½ | 31 | 29.95 | 29.93 | 29.87 | 49.56.58 | 42 | SW. SW. W. | |
| 30 | 50 | 63 | 64 | 42 | 29.83 | 29.87 | 29.79 | 56.61.63 | 49 | SW. SW. SW. | |

We are gratified in receiving from our esteemed correspondent, the foregoing remarks and meteorological observations, so much in unison with the wishes heretofore expressed in this Journal. It is, however, more especially desirable that *simultaneous* observations, *on the plan*, and *at the periods*, recommended at page 190 of our last volume, should be made throughout our country.

COM. PUB.

## Franklin Institute.

### *Conversation Meeting.*

The fourth monthly conversation meeting of the season was held at the Hall of the Institute on Thursday evening, 28th of December.

Mr. James Swaim exhibited, for the second time, his powerful magneto-electric machine, and, as on the former occasion, it excited much astonishment in all who had the temerity to try its effects, and produced no little amusement at the expense of the experimenters.

Mr. Andrew Stevens put in operation a model of Mr. Davenport's galvano magnetic machine, similar to those at the Masonic Hall.

Dr. Robert Rogers presented to the Institute one of his revolving galvanic batteries, designed to maintain constant activity.

A very neat specimen of statuary, from the chisel of Mr. Drache, was presented to the Institute by that artist.

Mr. W. F. Ketchum exhibited his method of increasing the adhesion of locomotives on inclined planes, by means of small driving wheels fixed on the axles, outside of the large wheels, and adapted to an angular, or wedge shaped rail, laid on the steep grades, and raised above the ordinary rail.

Numerous samples of American manufactured hardware and cutlery were exhibited by Messrs. W. H. Carr & Co., Messrs. Curtis & Hand, and Messrs. English and Huber, also some beautiful specimens of American cut glass, by Mr. Wm. Muzzy.

The Hall was visited in the course of the evening by Governor Ritner, and a number of other distinguished strangers, who expressed much gratification at witnessing the interesting display of scientific and mechanical novelties.

## Mechanics' Register.

### LIST OF AMERICAN PATENTS WHICH ISSUED IN APRIL, 1837.

### *With Exemplifications and Remarks by the Editor.*

52. For improvements in the *Manufacture of White Lead;* Peregrine Phillips, Campbell county, Kentucky, April 17.

The lead is to be rolled into sheets, or shotted, but it is preferred to be feathered, that is, granulated, by pouring it, in a small stream, into water. The prepared lead is then to be placed in a vat with a perforated false bottom at about its middle, where the lead is to be sustained. A pump is to be placed so as to pass through the false bottom, or in such manner as to allow the liquid contained in the vat to be pumped up. A steam pipe, of pure tin, &c., is to pass once, or more times, round within the vessel; and a tube through which air may be blown, is also to pass into the vat, below the false bottom. Distilled vinegar, or dilute acetic acid, containing about two or three per cent of dry acetic acid, is then to be poured into the vessel, to such height as not to interfere with the passage of air through the feathered lead. The pump is then to be worked, and the liquid to be so distributed by it as that the lead shall be kept constantly moistened. The acid may be kept at a temperature of 85 or 90 degrees by the passing of steam through the steam pipe. A blowing apparatus is to be kept at work at the same time, throwing in atmospheric air, to oxidize the lead as it passes up among it, which oxide will be dissolved by the acid, forming an acetate. When saturation is perfect, the fluid is to be drawn off into a cooler, and a fresh portion supplied to the lead, and this repeated until the whole is dissolved. The saturation may be judged of by the specific gravity ceasing to increase.

The saturated liquid is to be put into a vat, called a carbonating vat, constructed like that for saturating, but, instead of lead, having twigs, or pebbles, &c., upon the false bottom. Upon this brushwood, &c., the saturated liquid is to be pumped, whilst a quantity of carbonic acid, or a mixture of it with other air, is to be forced into the vat below the false bottom, which as it passes up, will convert the acetate into a carbonate, and this, being insoluble, will fall to the bottom in the form of an impalpable powder. When the precipitation ceases, the liquid is to be drawn off, and used again in the first vat, and so on continuously. The precipitated lead is to be thoroughly washed, then dried, and the process is completed.

The whole apparatus used is clearly described, and full estimates are given of the respective ingredients necessary to produce the desired reaction. The following are the claims.

"I claim as my own invention, *first*, the oxidation of the lead, and dissolving of the said oxide by means of pumping or throwing diluted acetic acid, or vinegar over lead when in a state exposing a large proportion of surface, at the same time drawing, or forcing, a current of atmospheric air through the interstices of the said lead; and I claim this only for the purpose of preparing a liquor to be used in the manufacture of white lead.

"I claim *secondly*, the pumping or throwing the aforesaid solution of lead over any substance or materials placed in an atmosphere composed wholly, or in part, of carbonic acid gas, or for pumping or throwing the aforesaid solution into the atmosphere as before said, so that it shall fall down through the said atmosphere, for the purpose of manufacturing white lead.

"I claim *thirdly*, the purifying of the vapour of burning charcoal by causing the same to pass through a stratum of pebbles, or other substances, which substance shall be kept moist by the constant or occasional injection of water over them. And I claim this only for the purpose of assisting in the manufacture of white lead."

This latter claim refers to the removal of all dust, or other impurity, which might enter with the gas, and injure the colour of the lead.

We doubt the economy of the process of forming the acetate in the first instance, and are not aware of its superiority in any respect, to the usual mode of manufacturing that salt from litharge. The carbonating is substantially the same with the French process described in Gray's Operative Chemist, and in other works; the particular management described by the patentee is all that he can hold, as being the only novelty presented to us.

53. For improvements in *Smoke Stacks, Flues, &c.*; James Stimpson, City of Baltimore, April 17.

The object in view is said to be so to construct the chimneys, or flues of steam engines, smith's forges, &c., as to generate heat, and prevent the escape of sparks, ashes, cinders, or soot. The instrument is denominated the "draught accellerator, and centrifugal spark catcher." The contrivance itself is somewhat complex, and the description of it much more so. Much space is occupied also by directions to the workmen how to cut and join the separate parts, which is altogether foreign to the matter in hand. A part of the flue is to ascend in a spiral form, and in speaking of this, we have some philosophical information which seems to furnish one of the properties of a patentable article, novelty. Not to mar the affair, we will quote the passage.

"I should recommend the spiral to be so formed as to have the ascent go round with the sun, like a back handed screw;—as nature inclines fluids, air, &c., to move, when in a spiral or circular manner, with the sun. And as it is as easy to make it ascend one way as the other, it would be best to let nature have her own way."

The smoke from a steam engine furnace, &c., is to ascend up a pipe to some distance in the usual way; there is then an opening made in the side of the pipe, through which the draught is to pass into a flue ascending spirally around the pipe as its shaft, or centre; an outer case covers the outer edges of the spiral thread, so as to make an enclosed flue. This it is said, will give to the sparks, dust, &c., a centrifugal force, inclining them to fly off tangentially; and to enable them to do so, there are slats, or openings in various parts of the outer case of the spiral, which openings are covered by troughs, called receivers, leading downwards, in which the sparks, ashes, &c., are to be precipitated to the bottom, where they are received and retained until removed.

The claim is "the combination of the spiral flue, with the outlets and receivers, constructed as above set forth, or in any other manner whereby a centrifugal force is, or shall be, obtained," &c.

We wish that this contrivance may have the effect of removing a great nuisance in rail road travelling, but we do not anticipate it, being apprehensive that but a small portion of the sparks and ashes will leave the ascending current and find their way into the receivers.

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54. For an improvement in the *Tongues of Power Loom Shuttles;* Comfort B. Thorp, Smithfield, Providence county, Rhode Island, April 17. (See specification.)

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55. For a *Revolving Hand Rake for hay or grain;* Stephen Coats, Shoreham, Addison county, Vermont, April 17.

This revolving hand rake consists of a rake head which is about six feet long, with teeth about two feet ten inches long, running through said head, and projecting out on opposite sides. To this head is affixed a pair of shafts, within which the person drawing the rake is to walk, a strap passing in front of him to aid him in drawing. The rake head revolves on the hind ends of the shafts, in loops formed by iron straps, there being catches to stop the head in a proper position for raking, and a lever at the command of the operator, by which the rake can be disengaged when fully loaded, and thus allowing it to revolve so as to bring the opposite row of teeth into action. The claims are to the particular mode of constructing the operating parts as described in the specification.

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56. For a machine for *cramping leather for the legs of boots;* Jesse Van Winkle, Rochester, Monroe county, New York, April 17.

This machine, in its general construction, is like several others, differing only in certain special points of structure, which we shall not attempt to explain. The claim is made to the "slides or sliding planes, with the projecting bars, or narrow plates, for removing the wrinkles from the leather."

57. For improvements in the mode of *Propelling Boats on canals and rivers;* John Finlay, City of Baltimore, April 17.

A rail, or string piece, is to be placed along the side of the canal, or other water, or it may be so supported by posts as to stand above the boat. This rail is to be embraced between two friction wheels, bearing on opposite sides of it, one of which wheels is to be made to revolve by steam, or other power, on board the boat; the frame which carries the wheels being so constructed that it may vibrate, and adapt itself to the level of the water. It is proposed sometimes to place rails upon a tow path, with a carriage adapted thereto, to be drawn by horses, instead of allowing them to draw directly by a tow line attached to the boat.

"Now what I claim as my own invention, and wish to secure by letters patent, consists in the application of a string piece, or rail, secured to posts placed near the edge of the water in canals, or over the tops of boats used on canals or rivers, and applying to the sides of said string piece, or rail, a wheel or wheels attached by a frame to a boat, with joints so as to adapt the whole to the depth of the water, operating nearly in a horizontal line; and to which wheel or wheels I apply the propelling power, causing the boat to move with velocity and without injury to the banks of the canal. I also claim the use and application of the guide frame with the friction rollers, to keep the boat parallel with the canal. I also claim the use and application of a frame with wheels to operate on the road above described, for horses to move with on the tow path to propel boats on canals; said frame having two wheels whose planes are oblique to the horizon, secured by friction rollers acting on opposite sides of the rail, being easily removed so as to disengage the wheels from the rails when boats are required to pass each other, or for any other purpose. I also claim the use of my invention on the ice during winter, the boats being placed on runners."

A plan for propelling upon canals, in some points resembling the foregoing, was patented by Prof. Chas. Bonnycastle, of the University of Virginia, on the 21st January, 1834, and is described in our 14th volume, p. 118.

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58. For an improvement in the *Standing Press;* Joel Barns, City of Philadelphia, April 17. (See specification.)

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59. For an improvement in the manner of *Constructing Rail Roads;* Uri Emmons, Freehold, Monmouth county, New Jersey, April 17. (See specification, Vol. XIX, p. 480.)

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60. For improvements in *Fire Arms;* Elijah Fisher, Springfield, and Dexter N. Chamberlain, Boston, Massachusetts, April 17.

Behind the barrel of the gun, or rifle, a longitudinal slat, or mortice is made, into which the back end of the barrel opens. This rectangular opening is to receive a block, or piece of metal, which is so fitted as to slide easily through it. Into this piece of metal, several chambers are bored parallel to each other, and capable of being brought in succession to coincide with the bore of the barrel, a nipple being fixed over the rear of each chamber to receive a percussion cap. There are also the contrivances necessary for arresting the sliding block, and holding it in place, and also for forcing it into close contact with the barrel at the time of discharge.

"We claim as our invention and improvement, *first*, a piece or block of metal, having any number of chambers therein to contain separate charges of powder, balls, and shot, to slide in a rectiliniar direction through a slat or passage formed in such a manner between the barrel and breech, as to admit of the axis of each of the chambers to be brought in succession in a right line with, or to correspond to, the axis of the barrel. *Second.* The mode of confining the piece or block of metal in different positions by means of a pin, projecting from a sliding piece of metal, and notches formed in the edge of the face of the piece, or block of metal. *Third.* Forming the key wedge shaped, for the purpose of pressing the block close against the side of the slat, or end of the barrel, to prevent windage."

61. For improvement in the *Loom for Weaving Coach Lace, &c.;* Erastus B. Bigelow, West Boyleston, Worcester county, Massachusetts, April 17.

This coach lace power loom is very fully described, and well represented in the drawings. The novelties, also, are distinctly claimed; but we shall not attempt an epitome, as without the drawings it must be obscure; the insertion of the claims would also be useless, if given alone.

62. For a Furnace for *Smelting Iron Ore by the use of Anthracite Coal;* George E. Sellers, Upper Darby township, Delaware county, Pennsylvania, April 20.

In this furnace the fuel is to be contained in a stack distant from that in which the smelting is to be effected. The latter is to contain the ore, with the necessary flux, and such portion of coal as may be required to carbonate the iron. The tuyere is in front of the fuel stack, and on the opposite side of this is an opening, called a concentrating flue, leading into the smelting stack, and in this passage there is a depression forming a timp, or receiving chamber, into which the metal runs as it is smelted, the bottom being inclined for that purpose. The necessary devices for performing the different operations appropriate to a furnace are, of course, appended to this. It is not pretended that the placing the fuel in one stack, and the mine in the other, is, by itself, new; but the novelty claimed consists in the particular construction of the furnace in its combined character. The patentee says, "I do not intend to claim the parts described in their individual characters. There is nothing new, for example, in the mode of feeding adopted by me, or in the principle of passing the blast through a stack containing fuel only, and causing the blast and heated air, therefrom, to enter a second chamber containing the ore to be smelted, this having been previously performed, or essayed. But what I do claim is that particular arrangement of the respective parts of the within described furnace by which it may be distinguished from all those which have preceded it; intending by this particular arrangement, the manner of connecting the main furnace for fuel with that containing the ore to be reduced, by a concentrating flue, within which is contained a receiving bed for the reduced metal, constructed and operating in the manner herein set forth, combining the same with the smaller flue above it, for the purpose herein fully shown. I also claim the provision for removing the slag from the fuel under the main furnace, by means of one or two openings constructed for that purpose, upon the principle, or in the manner, described."

"The smaller flue," above referred to, is one situated above the concentrating flue, and like it leading from the fuel stack into the smelting stack; its design being to conduct a portion of the heat into the smelting stack at such height above the bottom as may be useful in preparing the materials for the full action of the blast.

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63. For a machine for washing *Iron and other ores;* Frederick Fredly, Logan township, Centre county, Pennsylvania, April 20.

The ore is to be put into a long polygonal receiver, which turns on gudgeons like a dash wheel, and this is made to revolve with its lower side dipping into a trough or cistern containing water. The axis of the receiver is inclined, the ore is put in at the upper end, and a portion of water is also scooped in at every revolution. There is an opening at the lower end for the materials to pass out. The things claimed are certain peculiar points not possessing more novelty than was absolutely necessary to justify the granting of a patent. They consist in "the inclined strips at the ends of the polygonal case for directing the ore from the upper to the lower end of it, and into the inclined spouts. The inclined spouts at the lower end of the case, and the scoops at the upper end."

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64. For an improved mode of *Applying the Blast to Furnaces;* John Barker, City of Baltimore, April 20. (See specification.)

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65. For a new *Body for Hats;* Hugh Moore, City of New York, April 28.

The following is the whole substance of the specification. "The body is formed of cloth, the warp of which is strong cotton yarn, and the weft of alternate layers of strong cotton yarn and whalebone; or otherwise made of split whalebone attached to any kind of cloth by an adhesive water proof composition. The bodies, of both kinds, are joined at the sides by needle work. The brims and crowns are made of the same material, and I have also made them with brims of Canton flannel, and felt, and the crowns of layers of muslin of different degrees of strength.

"What I claim as my invention, and desire to secure by letters patent, is the application of whalebone to hat bodies, by which they will be rendered more elastic and durable than those made of felt, calico, or any other substance."

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67. For a *Furnace for the Manufacture of Shear Steel, and of Cast Steel*, by the use of anthracite coal; Simeon Broadmeadow, City of New York, April 5.

The furnace described is said to be one which is calculated to make about one hundred and sixty pounds per day. The ash pit is to be in the usual form, about eighteen inches high, five inches diameter at bottom, and seven at top. The furnace part eighteen inches in diameter, and four feet six inches high from the grate bars: surmounted by a flue forty feet in height, and nine inches square.

There are to be six small interior flues, which are to surround the furnace inside, each having an aperture of about an inch square. These flues extend from the grate bars to a point a little above the top of the crucible, and, of course, built with the furnace, giving to its interior somewhat of a hexagonal form. They serve to admit air at their lower ends, and to deliver it at their upper ends, below the surface of the burning fuel, so as to produce perfect combustion about the upper part of the crucible. These flues may be varied in number.

The principal things relied on are these interior flues, and the great height of the furnace stack, "that is to say, a chimney of extraordinary height for the size of the furnace, and furnished with interior flues, operating in the manner, and for the purpose, set forth."

68. For a *Furnace for Smelting Iron by means of Anthracite Coal;* Simeon Broadmeadow, City of New York, April 5. (See specification.)

69. For an improvement in the *Lamp for Lighting Houses,* for which Letters Patent were obtained on the 6th of October 1835; Samuel Rust, City of New York, April 20.

The kind of lamp which is the subject of this patent, has the wick, which is flat, raised and depressed by a roller in the stopple, or burner. Mr. Rust has introduced several improvements into this kind of lamp, and has obtained patents for them at a date subsequent to that now under notice, and which will receive attention in due course. One of the claims made in the present instance, is to "the casting or making of the portion which constitutes the usual stopple, and the vessel of the common close lamp (which holds the oil) all in one piece." There is also a claim made to the "constructing of the roller in such lamps movable, to take out of the tube, or lamp, and put in at pleasure." As the stopple is solid with the lamp, it is necessary to leave an opening in the top for filling the lamp, and this is covered by a flat cap, or valve, which turns on a pin, which device is claimed as combined in a lamp of this description. There are some minor claims to particular things which need not be mentioned here. As respects the lamps themselves, we have them in use, and prefer them very much to the house lamps as commonly made.

70. For improvements in the *Rotary Steam Engine;* Roger M. Sherman, Fairfield, Connecticut, April 25.

We have had repeated occasions to record our want of confidence in the successful employment of rotary steam engines, and we have not yet arrived at a period when we can announce a change of opinion. The numerous engines of this kind which have been patented here and in Europe, might probably be arranged as constituting five or six different species, each of which has been presented under various modifications in matters of detail, by which modifications it has been hoped that the particular difficulties, and objections found to exist to them might be removed. Our opinion, however, is, that there must be some new species discovered before the rotary will become a competitor with the reciprocating engine, and that, therefore, the one now before us, will share the fate of its predecessors. We cannot, without the drawings, furnish an account of the new devices proposed by the present patentee. Some of them have a near resemblance to such as have been previously used, although differing enough from them to justify the grant of a patent. The following is an abstract of the claims.

The grooves in which the valves, or pistons rise and fall in a revolving chamber, or the so adapting the valves that they shall be rendered close by the pressure of the steam, without packing. The application of pressure by means of a spring upon the stop, causing it to bear upon the sides and bottom of the chamber, and prevent the escape of steam, without packing. The combination of packing rings with lateral springs acting thereon so as to prevent the escape of steam between the cap and the chamber, without the use of packing; and the pressure of the cap upon the revolving chamber by means of springs, to effect the same object."

71. For a *Cradle for Cutting Hemp;* Wilson A. Larimore, Paris, Bourbon county, Kentucky, April 25.

This is a modification of the common cradle, fitting it to the purpose of cutting hemp by hand. The claim is to " the construction of a bow, or guard, around the points of the fingers, and its extension to the post. Likewise the cord which confines the bow, and extends to the sneath. Likewise the confining of the scythe at the point to the frame, by a screw or otherwise. Likewise the hoop confined on, or near, the back of the scythe."

The object appears to be to render the instrument firm and steady, for cutting the heavy substance to which it is to be applied.

The points of the fingers are inserted into a hoop, connecting them together there as well as at their back ends, and from the frame thus formed a rope extends to the upper end of the sneath, to support said frame.

72. For an instrument for *Measuring and Draughting, preparatory to cutting out Garments;* William C. Bishop, Ovid, Seneca county, New York, April 25.

We have a specification and drawing of this instrument, but do not suppose the subject of sufficient general importance to justify the expense of an engraving, and the space for the description. The instrument consists of flexible graduated metallic straps, to which measuring tapes are attached, and the claim is to " the particular mode in which they are connected and arranged," which so far as we can judge in a matter foreign to our general pursuits, appears to adapt them well to the purpose intended.

73. For an improvement in the *Cotton Gin;* Alexander Jones, City of New Orleans, April 25.

The principal improvement in this cotton gin consists in the manner of feeding the seed to be cleaned. The seed is put into hoppers, the bottoms of which are formed of parallel bars, the spaces between these bars being such that the seed cotton may be drawn through by the teeth of revolving feed plates, constructed for that purpose. To regulate the feed the hoppers are made to raise and lower, giving to the teeth of the feed plates more or less hold. The claim is to " the method of feeding the cotton to the saws by means of hoppers and feeding cylinders, constructed and operating substantially upon the principles set forth."

74. For a *Bodkin for inserting Corset Rings;* Jonathan S. Turner, Middletown, Middlesex county, Connecticut, April 25.

Corset, or other grooved rings, are to be inserted into cloth or canvass by means of an instrument that will make a hole in the cloth of the size of the neck of the ring to be inserted, and at the same time convey the ring into the cloth. A taper bodkin is to be made of ivory, or other suitable material, and this is to be cut across at such distance from the point where it is equal to the diameter of the grooves, the two sections forming a point and handle. From the handle a pin is to project about an inch in length, and of a size fitting the hole in the corset ring. The point is to be bored to receive the pin projecting from the handle, and the instrument is complete.

To use it the corset ring is first put upon the pin, and the point then passed on to it, so that the ring is embraced between the two sections. The point is then forced through the cloth, up to the ring, and with the nail, scissors, or other instrument, the cloth around the hole is forced over the lip into the grooves. The claim is to the instrument as above described.

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75. For an improvement in *Many Chambered Cylinder Fire Arms;* Daniel Leavitt, Cabotville, Hampden county, Massachusetts, April 29.

This is one of those fire arms which have several chambers bored in a cylinder, the axis of which is parallel to the axis of the barrel of the gun, and which chambers can be successively made to coincide with the said barrel. Such revolving cylinders have heretofore been made flat at the end which fits against the barrel, and the present improvement consists in substituting a hemispherical, or convex form for this flat one, the back end of the barrel being so hollowed as shall make it fit accurately on to the cylinder. The object in view is to prevent the danger of accidental explosion in chambers not brought up to the barrel; a thing which is liable to occur in the flat ended cylinders from that portion of the charge which escapes between them and the barrel, but which cannot come into contact with the chambers when the end is convex.

"What I claim as my improvement, is the giving to the chambered or forward end of the cylinder a convex form, by which the ignition of the charge in a chamber contiguous to that which is being fired, is prevented, upon the principle, and in the manner herein set forth."

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76. For *Many Chambered, non recoil, Fire Arms;* John W. Cochran, City of New York, April 28.

In fire arms of this construction, the chambers are made around the periphery of a a short cylinder, say three inches and a half in diameter, and three fourths of an inch thick, said chambers being bored in towards the centre, and made somewhat conical. This is placed behind the barrel of the gun, so as to revolve horizontally when the gun is in a position for firing. Percussion caps are placed on nipples on the under side of the cylinder, there being suitable guards to prevent their accidental discharge. The following is the claim.

"What I claim as my invention in the within described many chambered fire arms, is the combination of a many chambered cylinder, the chambers of which are formed around the periphery in the way herein described, with a rifle, pistol, carbine, or other barrel, and combined also with the stock of such fire arm by means of the stock straps, connected substantially in the manner set forth. I also claim the combination of the percussion cap guard, together with the thin circular plate under it, with a cylinder constructed and connected as above set forth, for the protection of the percussion caps. I also claim the manner of connecting the barrel, in arms so constructed, with the rising piece of the under stock strap, by screwing it therein; the whole combined so as to constitute a fire arm substantially the same with the foregoing."

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77. For improvements in the *Many Chambered, non recoil, Fire Arms;* John W. Cochran, City of New York, April 29.

A principal object in the patent before us, is to construct the fire arms last described in such manner as to allow of the ready removal of a cylinder which has been exhausted, for one which is ready charged, by which means five or six cylinders contained in a belt, may be successively used, two or three seconds being sufficient to allow of the removal of one, and the substitution of another. For this purpose the upper stock strap, forming the upper side of the mortice, or opening, in which the cylinder is contained, is hinged to the back end of the barrel, so that it can be released by touching a thumb spring, thrown up, and the cylinder exchanged. A second improvement consists in leaving a space in the hinge joint of this strap, through which a portion of the fire and smoke which escapes between the cylinder and the barrel, may pass, this opening being immediately above their junction. The claims made are to these two distinct improvements.

It may be proper to observe that the application of Mr. Cochran for improvements in fire arms had been many months depending in the patent office, prior to the fire in December, 1836, when his papers and models shared the common fate of every thing contained in that department. Such also was the case with numerous other applications, and it is now noticed to account for the delay in issuing the patents, arising in the first instance from a desire on the part of the applicant to remodel his specifications in some particulars, and subsequently from the burning of the office.

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78. For an improvement in the *Spoke Shave;* Ira L. Beckwith, Quincy, Norfolk county, Massachusetts, April 29.

In this spoke shave there is a steel roller in front of the cutting edge of the knife, which roller turns freely on pivots at its ends; it extends the length of the knife, taking the place of the wood or metal which usually constitutes the front of the throat. The bearing of this roller is adjustable, so that as the knife wears away, it may be advanced towards it. A thin plate of steel, called a cap, is to be screwed on to the under side of the knife, to cause it to operate like a double iron plane, and shave against the grain. The claims are to these particular improvements.

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79. For an improvement in the *Joints of Carpenters' and other Rules;* Lemuel Hedge, City of Hartford, Connecticut, April 29.

This rule joint turns upon double centres, much in the manner of card table hinges, so that when the rule is closed the joint end will be square, like the two opposite, or opening ends. To insure the opening and closing correctly, there are two angular projections on the brass plates constituting a part of the joint, with corresponding shoulders, which though simple in construction, cannot be readily explained without a drawing. Since the patent for this joint was obtained, the same individual has obtained another for an improvement in it, which will come to be particularly noticed in due course.

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80. For an improvement in the *Spring Saddle;* Moses Baldwin, Cincinnati, Ohio, April 29.

The claim made is to "two thigh webs, and an additional pair of drawdowns; also the position of the springs and cantle plate; using for the purpose of making the two latter, iron, steel, or brass wire, varying in size to suit the weight of the rider."

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81. For improvements in the *Loom for Weaving various kinds*

*of Fabrics;* Christian W. Schonherr, of the kingdom of Saxony; patent dated March 31, but issued April 29.

Under the new Patent law, patents may be dated at a period prior to their issuing from the office, but not exceeding six months; this may account for some apparent discrepancies of dates in our lists.

This is a very ingeniously constructed hand loom, the description of which extends to a considerable length, and refers to numerous figures in the drawings; the particular construction of the parts claimed as improved cannot, therefore, be furnished in a brief way, but some idea of the design may be obtained from the claims, which are:

"*First.* The modes of actuating the treddles by levers and horizontal bands passing under pulleys, and springs, as described and set forth.

"*Secondly.* The arrangement of the picking straps, with the loop, or bridle, and horizontal check strings, leading to the spring lever; also the shuttle catcher bar, with its strap and spring rod.

"*Thirdly.* The mode of actuating the lathe, by means of a cam or tappet, together with the straps and their guide pullies, as also the spiral springs attached to the sword, for the purpose of drawing back the lathe as described.

"*Fourthly*, The arrangement of machinery as described, by which the giving out of the warp and taking up of the cloth is effected and regulated.

"*Fifthly.* The improved driving pulley as described, which, when the loom is turned by hand, may be made to act as a fly wheel.

"*Lastly.* The form of shuttle with the cavities described, and of the picker to be used therewith."

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## SPECIFICATIONS OF AMERICAN PATENT.

### *Specification of a Patent for an improvement in the mode of securing or holding the cop on the tongues of Power Loom Shuttles; granted to* COMFORT B. THORP, *Smithfield, Providence county, Rhode Island, April 17th,* 1837.

My improvement consists in a mode of more effectually securing and holding the cop, or woof, upon the tongues of the common power loom shuttle, than the mode now in use, preventing the cops, or woof, from sliding off from the tongues while weaving, especially the last part of them which so frequently slips from the common smooth tongues, and draw into the web, injuring the cloth, and wasting yarn.

My improvement consists of ridges, or parts jutting from the surface of said tongues, protruding into the cop, against which the innermost turns or coils of the woof will lodge and prevent the cops from sliding from the tongues.

There are various ways to form or produce such projections or protuberances, such as cutting notches in of a saw tooth form, the points or cutting part of which will stand towards the heel or pivot of the tongues, and about five eighths of an inch apart on each corner, and so arranged that neither of them will come opposite to another. The square of the tongue should be equal to the hole in the cop. Also by forming a worm, or spiral projecting lip or edge around the surface of the round tongues, or by cutting notches therein.

The most convenient way to form and use the improvement on the common smooth round tongue will be to wind a piece of wire around it, spirally, beginning at the head of the tongue near its pivot, and forming about eight turns, more or less, onward towards the point, each turn should be three eights of an inch apart, or thereabout. The wire should be the sixteenth of an inch in diameter, and confined to the tongue by soldering. It is necessary that the tongues should be made so small in size as to protrude into the cop with ease, before the wire is put on to said tongue. The most handy way to put the cop on to the screw tongue, will be to slip the cop on to its point until it comes to the worm, and then with one hand hold the cop and whirl the shuttle round.

What I claim as my invention, and desire to secure by Letters Patent, are the above described projections which protrude into the cop, for the purpose of more effectually securing and holding the cop or woof on upon said tongue. Also the application of the worm, or the spiral projecting lip or edge to the round tongue, as herein described, for the purpose of holding and preventing the cop from slipping off from the tongues of the shuttles while weaving.

Comfort B. Thorp.

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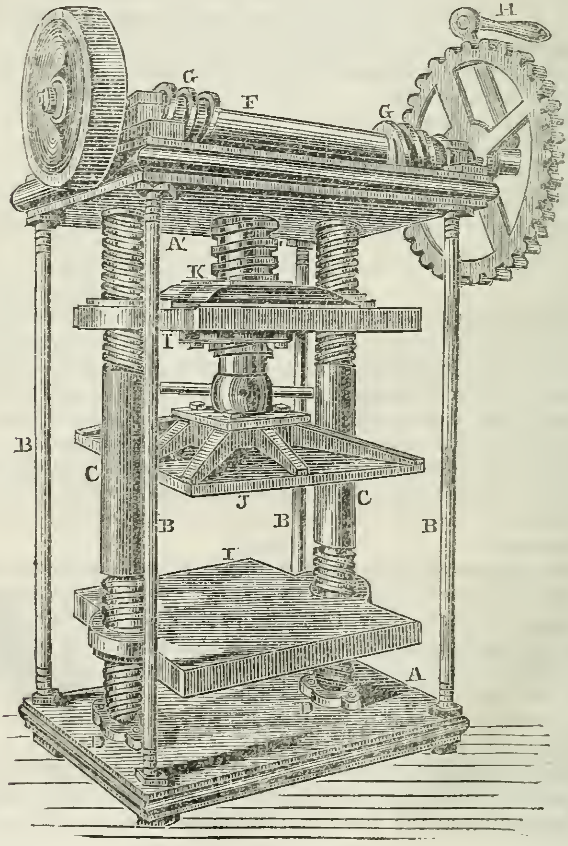
## *Specification of a patent for a standing Press, granted to* Joel Barns, *City of Philadelphia, April 17th* 1837.



To all whom it may concern, be it known, that I, Joel Barns, of the City of Philadelphia, have invented a new and improved Standing Press, to be used for the pressing of every kind of article to which such preses are adapted; and I do hereby declare that the following is a full and exact description thereof, reference being had to the drawings which accompany, and make a part of this specification.

A, A′, are the bottom and top plank, or plates, of the press, forming a part of its frame. B, B, are rods of iron passing through the top and bottom plates, and firmly secured to them by screw nuts, or otherwise. C, C, are two screw shafts, each of them having a right handed screw at one end, and a left handed screw at the other, a blank space, not formed into a screw, being left between them. These screw shafts pass through the plate A′, and revolve within a suitable collar; they also revolve in steps D, D, at their lower ends. A toothed wheel, or pinion, not seen in the drawing, is firmly fixed on each of these shafts, just above the upper plate A′, and a horizontal shaft F, carrying two endless screws G, G, which mash into the wheels or pinions, upon the screw shafts; G, G, when turned by mean of the winch H, or by a wheel and pinion, or any other suitable gearing, cause the screw shafts C, C, to revolve. I, I, are two plattens, or followers, having nuts, or screw boxes, on or within them, adapted to the screws of the shafts; and it will be apparent that by the revolving of the shaft F, these plattens, or followers, will be made to approach towards, or to recede from each other as may be desired. A third platten, or follower, J, has a screw K, attached to, and swiveling on it, in the manner of the ordinary screw press, the female screw or nut, within which it works, being fixed in the platten I; the upper end of this screw passes freely through a hole in the centre of the upper plate A′. The use of this platten is to save time by the ease and rapidity with which it may be raised or lowered, instead of raising or lowering the two plattens first named. To effect this with the greater facility, I usually make the thread of the screw K, considerably coarser than that on the shafts C, C, the power of the press being dependent, in a great measure upon the cutting the latter as fine as is compatible with the necessary strength.

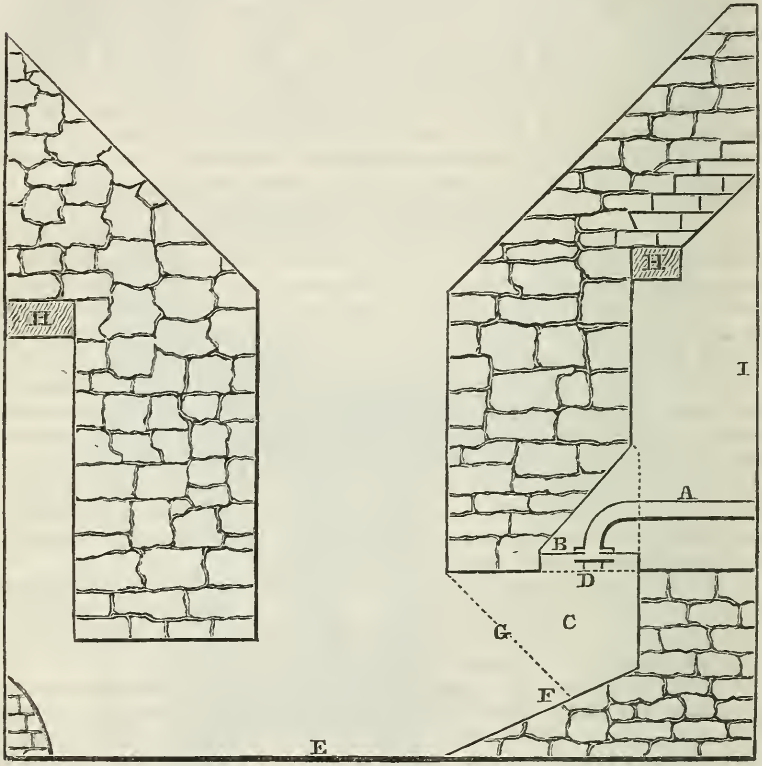
It has not been thought necessary to give any particular dimensions, or the proportions of the respective parts to each other, as these will vary with the purpose to which the press is to be applied, and can be duly adjusted by any competent workman.

Having thus fully described the construction of my newly invented press, and the manner in which the same operates, I do hereby declare that I do not intend to claim the mere application of a shaft with a right and left handed screw upon it, or either of the parts of the press described taken individually, and alone, as my invention, these being well known as elements of other machines; but what I do claim, and wish to secure by Letters Patent, is the combination of these parts constituting a press with three plattens, or followers, two of which are operated on by shafts having right aud left handed screws, turned by a gearing constructed and arranged substantially in the manner herein described, whilst the third platten is raised and lowered by means of an independent screw, in the manner herein fully set forth.

Joel Barns.

### *Specification of a Patent for an improved mode of applying the Blast to furnaces, granted to* JOHN BARKER, *City of Baltimore, April 20th,* 1837.

To all whom it may concern: be it known, that I, John Barker, of the City of Baltimore, in the state of Maryland, have invented a new and improved mode of applying the Blast to Furnaces for the smelting, or fusing of metals, and which is particularly applicable to those erected for the manufacturing of iron: and I do hereby declare that the following is a full and exact description thereof, reference being had to the drawing which accompanies, and makes a part of this specification.



The drawing shows a section of an ordinary sized smelting furnace, and represents such part thereof, as is necessary to a clear understanding of my invention, which consists in a mode of introducing the air from the blowing apparatus diffusively, without impinging upon the ignited fuel as it does when introduced through the tuyere in the ordinary way; by which diffusion there is an essential difference in the results produced, the action of the air being from the very commencement of its introduction, by gradual and easy pressure.

A, represents the blow pipe, connected with the blowing apparatus, and passing through the tuyere arch to the furnace. This pipe should not be less than three inches in diameter, but it may be made much larger, and its being so will rather aid than abstract from the result at which I aim; the quantity of air introduced through it, is altogether independent of its size, this being goverued by the number of strokes made by the pistons, and the capacity of the blowing apparatus. From the blow pipe A, the air passes into a square, round, or other shaped box, B, made of sheet or of cast iron, the horizontal section of which may be a square foot, more or less, and its depth about two inches. The lower face of this box is preforated with numerous holes, through which the air is to pass into the chamber C, of the furnace, by which means the blast will enter over the whole area of the face of the plate. To prevent its impinging too forcibly upon the centre portion of the plate, a small plate D, may be placed directly under the blow pipe, so as to diffuse the blast; or a similar result may be obtained by making the perforations about the middle of the lower plate much smaller than towards its outer edges. The bed stone E, may be continued in a horizontal position under the chamber C, but I prefer to give it an inclination at that part, as shown at F, as this will dispose any matter in fusion to descend towards the middle of the furnace. When this part is constructed, as shown in the drawing, the coal and other materials in the furnace, as they descend, will assume a position near the chamber C, something like that shown by the dotted line G, leaving a clear space under the box B, for the admission and expansion of the air, which will consequently, be forced into the fuel by an equable pressure over a large surface, as intended by me. In the position given to the box B, also, there will be a perfect security against its being obstructed by the coal, or other matter within the furnace. There may be two or more blow pipes, operating in the way described, just as there may be two or more tuyeres when the blast is introduced on the ordinary plan.

Instead of the box, B, a trumpet mouthed pipe may be used, as may also other analogous contrivances to diffuse the blast in the chamber, which diffusion is the great object that I have in view; and for this purpose my furnace must always be so constructed as to have a chamber, operating like that marked C, free from fuel, through a space sufficient to allow a large surface to be exposed of that portion of the burning fuel into which the air from the blast is first to enter, which surface is represented by the dotted line G. In whatever way, therefore, the *proper quantity* of air is introduced, provided it be such as will allow of its *diffusion in a chamber*, constructed so as to operate like that marked C, before it comes into contact with the burning fuel, my purpose will be accomplished, and my invention adopted. This may be done even when the blast is introduced into the chamber by the common blow pipe although it should be directed towards the burning fuel, as the chamber is intended to equalize the blast before its contact with the burning fuel. The chamber C, for example, may be extended in height, by enclosing that part of the tuyere arch shown by the dotted line H, and blowing into it by the ordinary blow pipe which would then perform the office of the pipe A, the box D being removed.

Having thus fully described what I believe to be the best mode of attaining the end which I propose, namely, the introduction of the blast into a furnace under an equable, but comparatively light, pressure, by diffusing it, at its entrance, over a large surface, without diminishing it in quantity, I do hereby declare that I do not intend to limit myself to any particular proportions, or dimensions of the parts of my apparatus, or to any precise location thereof; but I claim as my invention the diffusing of the blast *in a chamber* as it enters a furnace, in the manner, and for the purpose, herein set forth, whether the apparatus be constructed in the way described, or in any other which is substantially the same.

JOHN BARKER.

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### *Specification of a Patent for a mode of constructing Furnaces for the smelting of Iron Ore by the use of hard, or anthracite coal; granted to* SIMEON BROADMEADOW, *City of New York, April* 5, 1837.

To all whom it may concern: Be it known, that I, Simeon Broadmeadow, of the City of New York, in the State of New York, have invented a new and improved mode of constructing Furnaces for the smelting of iron ore by the use of hard, or anthracite coal, as a fuel, and I do hereby declare that the following is a full and exact description thereof.

The dimensions of the respective parts of my furnace, which I am about to give, are such as will designate one of ordinary size; my object therein being to afford a clear view of its general construction and arrangement, without intending to limit myself to the precise admeasurements set down, but rather to exhibit a general character by which any competent iron master will be enabled to see the difference between my furnace, and all those which have preceded it, and also to construct the same.

The whole height of the furnace, above the hearth, is twenty-five feet. The form of the stack above the tymp is that of two truncated cones, the bases of which unite at the middle of the stack, whence they regularly taper to the diameter of two feet at the top, and the same at the tymp. The tymp must be eighteen inches long and nine inches deep, as will be seen by the drawing (deposited in the patent office,) which is drawn upon a scale of half an inch to the foot. The hearth below the tymp, where the molten iron lies ready to be drawn off, is three feet square, and two feet deep; whence the slag, or dead cinders, are to be thrown off, as in other furnaces. I use two tuyeres, which at the inlet are each two inches in diameter. The pressure of the blast is two pounds and a half to the square inch.

Should the furnace much exceed the height designated, the weight of the anthracite, and of the ore, will be such as to obstruct the passage of the blast through the mass, and consequently to defeat the process; but by keeping to the proportions given, the pressure of the mass upon the tuyere will be moderated, and the blast will readily find its way to the top of the furnace, and a good working heat be attained.

In using such a furnace, I first heat it by putting in 300 bushels of charcoal; I then charge it by putting in 200 lbs. of hard coal, then 200 lbs. of iron ore, and fifty pounds of lime stone; repeating the charge as the materials sink, treating it in these particulars in the ordinary mode of managing furnaces for making iron. The ore is to be roasted, and otherwise prepared, in the ordinary way; and I of course vary the flux, and other things, according to the nature of the ore to be smelted.

What I claim as my invention, and wish to secure by letters patent, is the construction and employment of such a furnace as that herein described, for smelting iron by means of anthracite, or hard coal; that is to say, a furnace which is substantially the same with that described, in the general structure, proportion, and arrangement of the parts containing the ore to be smelted.

SIMEON BROADMEADOW.

## Progress of Practical and Theoretical Mechanics and Chemistry.

### *A description of the most powerful electro-magnet yet constructed. By the* REV. N. J. CALLAN, *Professor of Natural Philosophy in the R. C. College, Maynooth.*

I have lately constructed for the College, an electro-magnet which far surpasses in electric and magnetic power, all the electro-magnets of which I have been able to find a description. The iron bar of our magnet weighs 15 stone; it is 2½ inches in diameter, and more than 13 feet in length. It is bent into the form of a horse shoe; the distance between the poles is 7 inches. A copper wire $\frac{1}{6}$ of an inch diameter is coiled once round the whole length of the iron bar. This wire is divided into 7 parts, each about 70 feet long. A thin copper wire about $\frac{1}{40}$ of an inch in diameter is soldered to one of the thick wires at about a foot from one of its extremities. The thin wire is about 10,000 feet long, it is wound round the magnet in the same direction as the thick wire, and in one continuous coil. By connecting the opposite ends of the seven thick wires with the opposite poles of a powerful galvanic battery, an extraordinary magnetic power is communicated to the iron bar; and, by breaking the battery communication, an electric current of enormous intensity is excited in the long coil of thin wire. I have tried the magnetic and electric powers of this magnet only once. In consequence of making the trial, in presence of about 300 of the students, I was compelled to omit many of the experiments which I intended to make, and which I expect to make before the end of this month.

In exhibiting the power of the magnet, I first used our large battery of 20 pairs of plates, each 2 feet square, and afterwards, a Wollaston battery containing 280 pairs of 4 inch plates. When the opposite extremities of the 7 thick wires were connected with the opposite ends of the battery of large or of small plates, we found it impossible to separate the keeper from the magnet by any force acting in a direction opposite to that in which the magnetic power was exerted. The keeper was a horse-shoe bar of iron about 20 inches long and 2½ inches diameter. The highest point of the arc formed by the keeper was 7 inches. The distance between its poles was the same as the distance between the poles of the electro-magnet. Its weight was about 28 pounds. When the electro-magnet was placed in a horizontal position, and the keeper applied to it, the magnetic power was so great (when the battery of large plates was employed) that the keeper remained without any support, in a horizontal position; and a weight of about 40 pounds, acting at 7 inches from the poles, or at the highest point of the curve formed by the keeper, was required to turn it out of the horizontal position. The poles of the magnet were so badly ground that a great part of the keeper was at a sensible distance from the magnet.

The magnetic power produced by the 20 large plates was considerably greater than that which was communicated to the iron bar, by the 280 pairs of small plates.

The great electric power of the magnet, or its power of exciting an electric current in the helix at the moment battery connexion is broken, was shown by the most brilliant combustion of charcoal, and by the destruction of animal life.

To one end of the oscillating wire belonging to the electro-magnetic repeater, I tied with a fine metallic wire, a piece of charcoal, in such a way that, on working the repeater, the extremity of the wire and the point of the charcoal should dip simultaneously into the mercury, and should rise simultaneously from it. The opposite ends of the thick wires coiled on the electro-magnet were connected with the opposite ends of our large battery, and the connexion was broken very rapidly by means of the electro-magnetic repeater. As often as the connexion was broken the charcoal and mercury were ignited by the electric current excited in the thick wires coiled round the magnet. The succession of sparks produced by the ignition of charcoal and mercury, was so rapid that they formed one continued blaze of the most vivid light. The combustion of charcoal and mercury was accompanied by a large quantity of smoke, and was much more brilliant than that which is produced by a voltaic current passed from the battery employed, through a pair of charcoal points.

When, by means of an electro-magnetic repeater, a rapid succession of the electro currents excited in the long coil of thin wire, (at the moment of breaking battery connexion) was passed through charcoal points, they were but slightly ignited. But, although the igniting power of the electric current produced in the long coil of thin wire, was very feeble, its intensity was exceedingly great. For, when it was passed through the body of a large fowl, instant death was produced.

I have not as yet examined the decomposing power of our magnet; but I will shortly try it on some of the simple substances.

I found about four months ago, that an electric current capable of giving a shock, and consequently of producing decomposition, is excited in the helix of an electro-magnet on making, as well as on breaking battery connexion, when the thick wire coiled on the iron bar is short, and when the thin wire is long. Hence it is impossible to obtain separately the elements of bodies decomposed by the electro-magnet. For a similar reason it appears to me impossible to obtain separately the elements of substances decomposed by the magneto-electric machine. The shock given by the magnetic helix, on *making* battery connexion is weak compared with that which is given, on *breaking* communication. It increases with the number of plates in the battery.

I am now engaged in making an electro-magnetic engine to be worked by our large magnet, or by 26 smaller electro-magnets. Should the engine work well, I expect to send you a description of it, in time for publication in the October number of the Annals.

Maynooth College, June 14, 1836.

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In a paper published in the July number of the Annals, I stated that I was then employed in making an electro-magnetic engine to be worked by 26 electro-magnets. In the end of June, I tried the engine before it was completed, and found these two defects in it. The first was that some of the magnets were connected by iron where they ought to have been connected by a substance not susceptible of magnetism; the second arose from the number of magnets which were divided into two sets, each containing 13 magnets. I found it impossible in the plan which I adopted, to make an odd number of magnets work, and was therefore obliged to reduce the number of magnets to 24: or to two sets each containing 12 magnets. I also substituted a brass connexion between the magnets for the iron one. I then found that one small electro-magnet was capable of producing circular motion in a wheel which weighed about 100 pounds, and that six magnets were sufficient to give rapid motion to the wheel. The results of the experiments which I made, convinced me that electro-magnetism might be successfully applied to the working of machinery of every kind and I resolved to get made an engine which would do the work of one horse, or perhaps two. This engine will contain 40 electro-magnets, and I expect that, with a battery containing six square feet of zinc, it will propel, at the rate of 7 or 8 miles an hour, a carriage which along with its load, will weigh 13 cwt. The engine will be ready for work in the end of this month or in the beginning of next. By calculations founded on experiment, I have been led to the following conclusions. First, that an electro-magnetic engine as powerful as any of the steam engines on the Kingston Railway, may be constructed for the sum of £250; secondly, that the weight of such engine will not exceed two tons; thirdly, that the annual expense of working and repairing it will not be more than £300. If my calculations be correct, the expense of propelling the railway carriages by electro-magnetism, will be scarcely one fourth of the cost of steam. I have found that the first cost of an electro-magnetic engine, and the expense of working and repairing it, increase only as the square root of the power of the engine. Thus the first cost of an engine of 100 horse power, and the expense of working it will be very little more than ten times the cost of an engine of one horse power. A battery containing 10 square feet of zinc will work an engine 100 times as powerful as that which requires only one square foot of zinc.

N. J. CALLAN.

Maynooth College, September 11th, 1837.

Annals of Electricity.

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## *Temporary Caissoon for stopping out water while repairing sea-cocks of Steam Vessels.*

The following description of a temporary caissoon, applied to H. M. steam-vessel Dee, for the purpose of excluding the water whilst one of the sea-cocks was ground in afresh, by Com. W. Ramsay, R. N., displays that ingenuity under difficulty, for which our seamen are celebrated:—

In describing a caissoon that was used by H. M. steam-vessel Dee, under my command at Port Royal, in the month of August, 1835, the simplicity of the details are such, that it may perhaps be thought by some hardly worthy the attention of the readers of the Nautical; but as all who may have to encountre a similar difficulty may not know how easily it can be overcome, is a sufficient reason for giving them. It is necessary first to state, for the information of those who are not much acquainted with the fittings of steam-vessels, that there are several sea-cocks, which, when turned, admit the water through the bottom of the vessel for various well-known purposes. The most common plan is to have a pipe, which communicates with the sea. About a foot from the outside of the vessel is the cock, upon which another pipe is fixed which conveys the water to its destination. Now these cocks, by constant use, are liable to leak; when this occurs, the water flows in a stream into the vessel, and the only remedy to be applied is to remove the cock and what is technically called, grind it in afresh, and then replace it. This is, of course, effected without danger when the vessel is in dock, but it is evident, that if attempted when she is afloat, without some method of preventing the water rushing in, if the pipe inside cannot be stopped, which would be very doubtful, the vessel would fill with water.

This being premised, it may be now stated that the sea-cock on the larboard side of H. M. steam-vessel Dee was found to be leaking very much. It was considered that taking off the cock, and trusting to being able to stop the pipe from inside would be dangerous, besides the difficulty, perhaps impossibility, of putting the cock on again when reground, with such a rush of water as it is evident would take place. As there are no locks at Port Royal, the only plan was to stop the aperture (by which means the water enters the vessel) outside, until the necessary repairs were completed.

The vessel was first given as great a heel as possible to starboad, by which the hole to be stopped was brought within four feet of the water's edge; next, having procured several feet of two inch fir plank, a box was made which had three sides, and a bottom, of the following dimensions: the back was five feet deep by four broad, the sides three feet broad, the bottom of course extending from the back to the ends of the sides. The way in which it was rendered water-tight was this: two folds of very thick fearnought boiled in a mixture of tallow and tar was placed between each joining of the planks, and the whole was kept together by the means of iron bolts, which were driven quite through. Now, it was necessary to obtain the exact curve of the vessel's bottom, that the sides of the caissoon might be cut to answer to it. This was effected by means of a long stripe of lead, which was forced during a calm against the vessel's bottom. The curve being thus obtained, the sides and bottom of the caissoon were cut to their proper shapes; small grooves were cut in their edges, and four folds of fearnought, prepared as above, were nailed on. The nails were driven along the grooves. so that when the caissoon came to be pressed against the vessel's bottom, there might be nothing to prevent a good fit. Two large cleets were then nailed upon the vessel's side, on the exact spot that the top of the caissoon would be, so that once forced down into its place, it could not rise again. As near the surface of the water as possible, two strong screw eye-bolts were fixed to the vessel's side, through which lashings were rove, and a tackle got all ready.

The caissoon was now put over, forced down under the cleets mentioned above, the lashings encompassed it, which were hauled tight by the tackle by which means the caissoon was forced against the vessel. A small pump that had been prepared before, was then placed in it, by the aid of which, and bailing, all the water was got out of the caissoon in about ten minutes, after which one man occasionally bailing kept it quite dry. Having this to work in, the aperture was soon secured, the cock taken off and ground afresh. When that was finished and put in again, the caissoon, which had been allowed to fill with water was pumped out, the lead and plank that had been nailed on to keep the water out of the ship, was taken off, and the whole business was finished without the slightest stop, impediment, or difficulty, in about forty-eight hours.

Nautical Mag.

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## *Hot Blast Iron.—British Association.*

The *Manufacture of Iron* occupied a very large portion of the time of the section. The first paper on this subject was by Mr. G. Crane, of Ynyscedwyn Iron Works, on the smelting of iron by anthracite coal, of which fully a third of the immense coal field of South Wales, is composed. Mr. Crane had smelted a ton of iron with 27 cwt. of anthracite coal with very satisfactory results as to quality, and found a very considerable saving in using it in preference to bituminous coal. The smelting was now conducted by a cupola furnace, into which a stream of air was urged of heat sufficient to melt lead, this hot blast being all that was requisite to produce the combustion of the coal necessary for the reduction of the ore.

Dr. Thomson gave an account of the result of the experiments carried on at the request of the Association, on the *Comparative Advantages of Hot and Cold Blast Iron.* He had analyzed more than thirty specimens of the Glasgow ore selected with great care, the richest of which had a specific gravity of 3.056, with nearly 85½ per cent. of iron. The roasting of the ore before it was put into the furnace, in order to drive off the carbonic acid, reduced it 85 per cent. Formerly in smelting, ten tons of coal were used for the reduction of one ton of iron. In 1823, when the hot blast was introduced, 2 tons 19 cwt. only were required; 19 cwt. being consumed in heating the air and the boiler of the steam engine. Coals were therefore greatly economised by the hot blast, which produced a concentration of the combustion, and therefore melted the iron in a greater degree. A smaller quantity of lime was required for fusing the clay, and hence a greater quantity of cast iron could be obtained from a furnace in a given time. He had been, from the Carron Iron Works, which were of high reputation, supplied with specimens of No. 1 iron, made from hot and cold furnaces, and found the gravity of the cold blast less than that of the hot blast iron. One specimen of the hot blast iron, No. 2, contained 90½ per cent. of iron. From five specimens of the hot blast from different places, he had obtained a mean of 95½ per cent. of iron. Hot blast was decidedly purer than cold blast full five per cent., and they were of equal strength. The force required to break both sorts was the same, being 2040 lbs., where the iron was ⅝ of an inch thick. A chain of ⅞ths thick, forged from the hot blast iron, had stood the test of 22 tons 7 cwt., twelve tons above the Liverpool chain cable test. The saving in the coal by hot blast was two thirds. No phosphorus had been found in the iron analyzed by him.

Mr. Guest had found a much larger portion of the hot blast lost than of the cold blast in converting it into malleable iron.

Mag. Pop. Sci.

## *Upon the Affinity which the Fluids of living organized Structures have for Water.* By M. de Blainville.

Naturalists have long observed how much the hygrometrical and statical condition of the atmosphere; in other words, how much its moisture and weight, exerts an influence over the life of animals, influencing their form, whether small, sleek, and elegant, or on the contrary, heavy, lumpish, and swollen, according as this medium of existence is dry and in brisk movement, or on the reverse, saturated with humidity and stagnant, as is well exemplified by comparing together the inhabitants of Holland and Andalusia. They have also noticed that the habitual use of free potations and watery viands, or on the contrary, very nourishing and dry food, have a manifest effect on the condition of man and animals. As, however, these different results require a longer or shorter time before they take effect, their mode of action, we conceive, cannot be so manifest as it was on the occasion of an observation made in Egypt by M. P. E. Botta, a naturalist connected with the Natural History Museum of Paris, and now travelling in Arabia Felix. His remark is this: Camels, as is well known, are the only means of transport which can be employed in traversing the vast deserts which are encountered in many parts of Africa and Arabia, and this on account of their nature, and still more their habits in which they are reared from their youth, in virtue of which they acquire a power of abstinence to an extraordinary extent, being enabled to refrain from eating, and especially from drinking, during almost an incredible space of time. Here, however, we may remark in passing, that this remarkable power is not to be attributed to the circumstance that these animals are provided with a sort of stomachic reservoir, in which they husband their supply of water, as has been long alleged, and is still repeated in many of our modern publications, but is owing merely to the great extent of the salivary apparatus, which in all animals has a development in the ratio of its common food. Now, during the long journeys across the portion of the great desert which begins or ends at some distance from Cairo, according as you ascend or descend the Nile, M. Botta had occasion to observe that these camels, in proportion as they proceeded from the place of departure, became thin with a rapidity which was very striking and remarkable. He had also occasion to confirm an observation which was made ages ago, that these animals really seemed to smell water at incredible distances, which is inferred from the increased swiftness in the speed of the camels; which, in spite of their enfeebled power, during the progress of a protracted journey, redouble their efforts as they approach the spots where water is found, in hopes of obtaining that refreshing draught which can alone satisfy their thirst and relieve their torments. So soon as these animals reach one of those springs so sparingly scattered over the desert, they throw themselves into it with avidity, and though more or less muddy, they continue drinking it for a long time. That which most of all astonished M. Botta was the almost instantaneous change which this treat produced in them. In fact, after having been in this way reduced to the worst and most meagre condition, after the expiration of a short period of repose, and having drank well, they rise in so much apparent flesh and good condition, that you could scarcely believe them to be the same animals. Since, therefore, there was no other change in their regimen than the introduction into their stomach of a handful of dry nourishment, and of a great quantity of water with which they had just before gorged themselves, it is clear that this alteration in their condition, so sudden and so apparent, can be attributed only to the introduction of the watery fluid first into their stomach, then into the circulating fluids, and, finally, into the cellular tissue, in consequence of a true act of imbibation through the continuity of substance, whether circular or capillary, as in a sponge, and perhaps also by that process which is now denominated *endosmose;* that is to say, by the affinity which the liquids of a living organized part have for moisture, after they have been deprived of it by great exhalation. Ed. New Phil. Jour.

## *Miners' Patent Safety Fuse.*

In our present number will be found a brief report of an application made to restrain a party from manufacturing the "Miners' Patent Safety Fuse," which article we have had frequent occasion to notice as being one of the most important and useful inventions connected with mining.

We shall endeavor briefly to describe its properties, and thus enable those who have embarked in mining pursuits to judge of the value to be attached to the use of the "fuse," while its safety is in itself one of its strongest recommendations.

The "Patent Safety Fuse" is devised for safety and certainty in conveying fire to the charge in blasting rocks and in mining. It is in appearance like a firm varnished cord, just the size of a large goose quill, and has in its centre a continuous column of the best gunpowder—for convenient carrying and packing, it is manufactured in lengths, of twenty-four feet, coiled up like rope, the smallest coils being about three, and the largest about fifteen inches in external diameter, so that the different sized coils fall into each other and pack closely into small kegs or casks. It is so hard and firm in its texture, as to resist the action of tamping, is impervious to water, can be easily cut with a knife to any length, burns regularly in a measured time, conveying the fire at the rate of half a minute to the foot, and will act as certainly in a close rock firmly tamped up under twenty fathoms of water as on dry ground and in the open atmosphere.

The great advantages resulting from the use of this instrument have been acknowledged wherever it has been used. It offers protection to the workmen engaged in this hazardous employment; in large mining districts, where mutilation and death were frequent from premature explosions, accidents now very seldom occur. Its use occasions no trouble, but in comparison with every other mode greatly facilitates the operation. It is not only cheaper and more effectual than every other thing used for the purpose of certainly and slowly conveying fire to the charge, but is absolutely cheaper than blasting with the needle and straw, by saving a great portion of the powder necessary for the charge.

The Safety Fuse has consequently been long used in all the Cornish mines; has been strongly recommended by John Taylor, Esq., F. R. S., &c., Colonel Burgoyne, chairman of the Board of Public Works in Ireland, Mr. Purdy, secretary of the Mining Association of Ireland, and many distinguished scientific and practical gentlemen, connected with mining operations.

We can with justice add our testimony to its value, and do not hesitate to recommend its general adoption. We have before observed, that specimens of it may be seen at our office, or will with pleasure be transmitted to parties interested. Mining Journal.

### *On a New Rain Gauge.—By the Rev.* THOMAS KNOX.

On the 26th of June last, a new rain gauge was exhibited to the Royal Irish Academy, contrived by the Rev. Thomas Knox.

The object of this instrument is to register the amount of rain that falls when the wind is in different points. Its construction is very simple. The water—instead of descending from the reservoir directly into the tube of registry—passes through a lateral tube into an annular-shaped vessel, divided into eight compartments, each of which terminates below in a graduated glass tube. It is obvious, then, that if the eight tubes be set to correspond with the cardinal and intermediate points, and that the reservoir be made to revolve on a vertical axis by means of a vane, the direction of which corresponds with that of the lateral tube, the object proposed will be attained. Mr. Knox has preferred to make the reservoir fixed, and the system of tubes movable; but the result is obviously the same. Lon. & Ed. Philos. Mag.

### *On an Easy Method of preparing Platina Black.—By* M. DÖBOREINER.

*Translated for this Journal, by* JOHN GRISCOM.

Melt platina ore (crude platina) with double its weight of zinc, and treat the alloy thus obtained and reduced to powder,—first, by dilute sulphuric acid, and then by dilute nitric acid, in order to oxidate all the zinc. This, contrary to theory, is but slowly effected, even at a high temperature. A dark grey insoluble powder of native platina remains, mingled with osmiuret of iridium. This powder acts like platina black, after it has been properly purified by lixivium of potash, and it has such an oxidizing action that it transforms not only formic acid into carbonic, and alcohol into acetic acid, but even the osmium which it contains absorbs oxygen from the air, and is disengaged by degrees in the state of osmic acid.

This method of preparing platina in an extremely divided state, was recommended by Descotils thirty years ago, and he was the first to observe that the powder thus obtained detonates by heat like gunpowder, and that muriatic acid destroys this property.

When platina powder prepared by zinc is moistened with alcohol, it becomes incandescent and osmic acid is disengaged; but if it be mixed with alcohol so as to form a paste, and spread out on a watch glass, it disengages only acetic acid. This is the most simple process of purifying the air of a chamber. Jour. des Mines.

A process of purification rather too troublesome and expensive when ventilation and lime can be easily resorted to. It may, perhaps, be eligible in a sick room. TR.

# Progress of Physical Science.

### *Method of producing a Permanent Soap Bubble, illustrating the colours of Thin Plates. By* DR. J. READE.

The first account of the colours produced by thin plates is to be found in Mr. Boyle's works: "To show the chemist that colours may be made to appear or vanish, where there is no accession or change either of the sulphureous, the saline, or the mercurial principles of bodies, he says that all chemical essential oils, as also good spirits of wine, by shaking till they rise in bubbles, appear of various colours, which immediately vanish when the bubbles burst, so that a colourless liquor may be immediately made to exhibit a variety of colours and lose them in a moment without any change in its essential principles: he then mentions the colours that appear in soap bubbles, and also in turpentine. He sometimes got glass blown so *thin* as to exhibit similar colours." Here we may remark, that although Mr. Boyle did not advance any theory from these experiments, yet it is evident that he connected the production of colours with the thinness of the substance, as appears from his endeavours to blow glass sufficiently thin. This suggestion in all probability afterwards gave the idea to Dr. Hooke, and finally to Sir Isaac Newton, who has the merit of clothing Hook's suggestion in a mathematical dress, beautiful and interesting in the extreme.

Dr. Hook was the next to investigate this subject; at a meeting of the Royal Society, 7th March, 1672, he promised to exhibit at their next meeting something which had neither reflection nor refraction, and yet was diaphanous; he then produced a bubble of soap and water. It was no wonder that so curious an experiment should excite the interest of one of the most learned, liberal and scientific societies in Europe; they requested him to bring an account of it in writing at their next meeting. "By means of a glass pipe he blew several small bubbles out of a mixture of soap and water, when it was observable that at first they appeared white and clear, but that after some time the film growing thinner, there appeared upon it all the colours of the rainbow, first a pale yellow, then orange, red, purple, blue, green, with the same series of colours repeated." Sir Isaac Newton's experiments as exhibited in his Optics are so well known, that I shall not enumerate them in this paper, merely remarking that his bubble was so evanescent that it burst before he had time to make an accurate examination. Melville of Edinburgh thought to make a permanent soap film by means of freezing. This was impossible. It occurred to me that by taking off the atmospheric pressure, I might accomplish my purpose; I therefore made the following experiment.

*Exp.*—Having put two ounces of distilled water into an eight ounce phial, and having added about the size of a large pea of Castile soap, I placed the bottle in a saucepan of boiling water on the fire; the bottle was speedily filled with a dense volume of vapour, which expelled all the air. I now corked it, and after cooling, and thus condensing the vapour, had perhaps as perfect a vacuum as could be formed, even by the best air pump.* I now held the bottle laterally between my hands, and by means of a circular and brisk motion formed a circular film, on which

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*This vacuum, we apprehend, may be vitiated by the entrance of atmospheric air through the cork, indicating the necessity of covering it with cement.—EDIT. MAG.

by resting the bottle on an inclined plane, were formed after a short time all the parallel bands or series of colours in the following order: 1. a white or silvery segment at top; 2. a snuff-coloured brown inclining at bottom to a deep red; 3. blue; 4. yellow; 5. red; 6. blue; 7. green; 8. red: 9. green; 10. red; 11. green. (See Figures below.)

After some time a black segment was seen to form at the top of the white and continually to increase in size. After a few minutes the parallel bands increased in breadth, and running into one another only three or four distinct bands were seen. Nothing can exceed the beauty of these colours, equal to those of the rainbow, or the plumage of the tropics: whilst writing this description I have these bands in a bottle before me, feasting my eyes on their beauty. In a few minutes more this black segment of aqueous film occupies, perhaps, half the circular film, and the lower half becomes white tinged with orange.

If we now incline the bottle towards the experimenter's breast, the saponaceous atoms producing these colours are seen to float in the region of the black or aqueous: when placed again on the inclined plane they fall to the bottom of the films. In some time more the entire film becomes black, and all the colours disappear.

Having now placed the bottle in a basin of boiling water the evaporation was increased, and the black film soon became clothed with saponaceous atoms, which being variously condensed produced all the colours of the clouds when the sun is setting on a summer's evening. On again placing the bottle on the inclined plane the parallel bands were again formed by the attraction of cohesion, and the colours afterwards gave place to the black film. I held the bottle laterally between my hands, and by means of a circular motion washed it, and thus clothed it with saponaceous atoms, which went through the same process on placing the bottle on the inclined plane. By means of washing the film every morning, I preserved it for more than three weeks. This simple experiment opens a wide field of investigation to the natural philosopher, and enables him at his leisure to examine the interesting phenomena of these colours.

London, Sept. 4, 1837.

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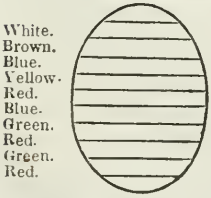

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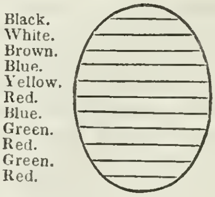

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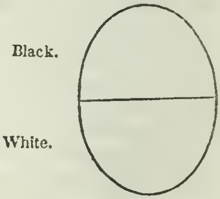

Lon. & Ed. Phil. Mag.

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## *On the luminous properties of Chloride of Calcium, by* Charles Tomlinson, Esq.

When chloride of lime is subjected to a red heat in a Hessian crucible, it undergoes the watery fusion and is gradually decomposed. Chlorine is at first evolved, then oxygen; and chloride of calcium remains in the crucible. This substance, when thus treated, emits a pale green phosphorescent light, visible in the dark, and was formerly called on this account, *Phosphorus of Homberg*, this chemist being the first to record the fact.

But when the chloride of lime is completely melted in its water of crystallization, if the crucible be removed to a darkened room and allowed to cool gradually, not only does the phosphorescent light remain for many minutes, but large and distinct electric sparks and corruscations are visible, accompanied by a crackling noise due probably to the sudden contraction of the mass, or to its crystallization.

These phenomena can also be seen in the dark by dipping a glass rod into the fluid, a large portion of which concretes around it, and can be withdrawn with the rod.

When the contents of the crucible have cooled down, and all phosphorescence has disappeared, the sparks can be obtained most admirably by striking the cloride with a sharp instrument of any material; by simply scratching it; or by snapping a piece asunder; or by percussion with a hammer; and both sparks and phosphorescence can be obtained by grinding the substance in a mortar, and the luminous effects remain for a few seconds after the grinding is discontinued.

The colour and intensity of the sparks thus produced seem to vary with the degree of mechanical force employed; thus, a gentle scratch produces green sparks; a firm scratch, yellow green; a blow with a sharp instrument, yellow; snapping a piece asunder also affords a yellow spark, and a smart blow with a hammer affords a spark of an orange colour.

All these effects are best seen with the newly fused chloride; it absorbs water by exposure to the air and its electrical properties gradually decline; I have, however, obtained the sparks from it after a few day's exposure, but they were wanting in the brilliancy which characterize those obtained from the substance when newly fused.

The term *phosphorescence* seems to be a very bad one and calculated to mislead; since it is highly probable that all recorded instances of phosphorescent minerals, &c. (except, of course, phosphorus itself and its compounds) are due to electricity. It has been shown by Dessaignes that metallic bodies are capable of electric excitation by the simple processes of heating and cooling. Morgan has shown that there is no fluid nor solid but may be rendered luminous by the transmission of an electrical discharge through its substance; and that the difficulty of producing this appearance in all bodies increases as the conducting power of the body decreases. Skrimshire has given a long list of minerals, in which calcarious bodies occupy a conspicuous part, which become phosphorescent by the electrical discharge; and Brewster also has a long list of mineral substances which become phosphorescent by heat. Now the appearance of the hot chloride of calcium is similar to that of white sugar, immediately after an electrical discharge has been transmitted through it. All calcarious substances present this appearance in a high degree when similarly treated, and the exciting cause is probably the same; for whether we employ the electrical battery or the hot crucible, heat is communicated to the substance, and heat is favourable to electrical excitation. A piece of lump sugar, mica, &c. when suddenly snapped asunder, and cotton cloth when suddenly torn, show the electric spark; so also does the fracture of the chloride of calcium. An enquiry, therefore, seems to be wanting into the connexion between phosphoresence and electricity since it is manifest that the appearances attending the slow combustion of phosphorus, and the light emitted by certain minerals when heated, &c. though similar in appearance are due to very different causes.

*Salisbury, March* 4, 1837. Annals of Electricity.

## *Atmospherical Phenomena.*

M. de le Rive read a second paper "On an Optical Phænomenon observed at Mount Blanc." When the sun has set at Geneva, it is observed that Mount Blanc remains illuminated by its direct rays for a much longer time, than the surrounding mountains. This phænomenon is owing to the great height of Mount Blanc. But after it had ceased to be illuminated, the summit of Mount Blanc sometimes appears at the end of ten or fifteen minutes, less intensely enlightened than at first, but nevertheless in a manner very decided, and often very brilliant. This phænomenon takes place especially when the atmosphere is very pure—highly charged with aqueous vapour in an invisible state—and, consequently, very transparent. The author has satisfied himself (by the exact observation of the time which elapses between the two successive illuminations of the mountain, combined with the calculation of the sun's progress) that the phenomenon is due to the rays of the sun which traverse the atmosphere at a distance from the earth less than the height of Mount Blanc, but greater than half that height, and which arrive at rarer regions of the atmosphere under an incidence so great that they are reflected instead of refracted. This interior reflection is facilitated by the humidity of that part of the atmosphere which the rays traverse until they reach the point of incidence. The reflected rays falling on the snowy summit of Mount Blanc, produce this second illumination; and the humidity (by augmenting the transparency of the air) renders the illumination more brilliant.

Sir D. Brewster stated, that he had witnessed a similar effect, though on a less magnificent scale, on the Grampian Hills; but he had always observed, that on such occasions the sun set in a red west, and that all the clouds in that quarter of the heavens were then red.—M. de la Rive replied, that the phænomenon he spoke of only appeared when the sky was quite free from clouds, and, in truth, it was most brilliant when the air was very transparent in consequence of its being loaded with vapour in its elastic state.—Professor Lloyd said, that the distinctness and vividnes with which distant objects were seen in some states of the atmosphere, was quite astonishing; on one occasion, he had seen from the neighbourhood of Dublin the Welsh hills from their very bases, and brought so near, apparently, that he could absolutely see the larger inequalities of the surface upon the sides of the mountains. That the atmosphere was at that time very much loaded with vapour in a highly transparent state, was obvious from the fact, that immediately after, a very heavy fall of rain took place, and continued for a considerable time. Professor Stevelly wished to confirm what had fallen from Professor Lloyd and M. de la Rive, by stating that whenever the Scottish hills appeared with that peculiar vividness and distinctness from the Lough of Belfast, the fishermen always looked upon it as a sure precursor of heavy rain and wind. A friend had informed him, that on one occasion he had noticed this appearance while standing on the beach at Hollywood, and pointed it out to an old fisherman; the old man immediately gave notice to all his friends to whom he had access, who instantly set about drawing up their boats and placing their small craft in more secure places; early the next morning a violent storm came on, which did much damage on the coast, to those who had not been similarly forewarned. Thus we find that the most interesting pursuits of the man of science, and the most important concerns of man in the practical details of life, frequently approach, and each may lend important aid to the other.—Mr. Lubbock was of opinion that the principal fact mentioned by M. de la Rive would receive a simple solution, if we admit the theory of Poisson regarding the constitution of the atmosphere. That eminent mathematician conceived that analysis led irresistibly to the conclusion that the upper portions of the atmosphere were, by the extreme cold there existing, condensed into a liquid, or even into a solid: if this were so, we could easily conceive how the reflection of the light from its under surface would re-illuminate the top of Mount Blanc after the direct light of the sun had ceased to reach it.—Sir David Brewster expressed much surprise at hearing, for the first time, of this theory of Poisson, and that he should feel much obliged to Mr. Lubbock if he would give some details of it in a separate communication to the Section; and he had little doubt but that it would be as new and acceptable to many gentlemen as to himself. He thought that the near apparent approach of distant objects in certain states of the air, as mentioned by Professor Lloyd and Professor Stevelly, might perhaps be accounted for by supposing that on these occasions the intervening air became actually converted into a large magnifying lens. Brit. Ass. for Adv. of Sci.—Mechan. Mag.

## *British Association.—Corrosion of Iron by Salt Water.—Singular action of Nitric Acid on Metals.*

Mr. Hartley read a paper "On the corroding of Iron by Salt Water." The object of the paper was to shew that brass protects both bar and cast iron in a very perfect manner. The brass did not appear to have undergone any action, which, as stated by the President, Dr. Faraday, is rather opposed to received notions of electro chemical action.

Dr. Andrews next read a paper, "On some Singular Modifications of the Ordinary Action of Nitric Acid on certain metals." Bismuth in nitric acid of specific gravity 1.4, was rapidly acted upon, but this action immediately ceased when the bar was touched by platinum. On removing the platinum from the liquor, the bismuth will sometimes begin again to dissolve; at other times, its surface will become covered with a black crust, which is soon removed by the acid; but the metal, though now exhibiting a beautifully polished surface, is no longer acted upon by the acid, or, at least, is dissolved only with extreme slowness. Thus, a slip of metal, which in its ordinary state will require only a few seconds to complete its solution, will, when thus slightly modified, resist, for many hours, the action of the same acid.

Copper and tin present similar phænomena, but zinc, when treated in the same way, has its oxidation and solution not arrested, but merely retarded. Arsenic was found to present a singular anomaly when heated in nitric acid, so as to give rise to effervescence: the contact of platinum in the usual way did not produce any effect, whereas, when an acidulous solution of silver is used, platinum exercised its usual influence.

In the case of six metals, platinum checks the action of nitric acid, and three of them appear to be brought into a permanently peculiar state opposed to chemical action. Platinum always separates any film of oxide as its initial function, but after its separation, it exercises a polarizing action; for example, it brings the other metal into a peculiar state, which enables it to resist chemical action.

On the conclusion of this paper, the President drew the attention of the Section to the analogy between the facts detailed by Dr. Andrews, and the preservation of iron by brass, as instanced in the communication of Mr. Hartley. In both cases, according to the known laws of electro-chemical action, effects, the very opposite of what are observed, should present themselves. The bismuth, copper, &c., should oxidize quickest when in contact with the platinum; and if, as would seem demonstrated by Mr. Hartley, brass protects wrought and cast iron, the brass itself should be acted upon with increased rapidity. The solution of these anomalies, he conceived quite within the range of science in its present state, and he urged upon the members of the section the necessity of studying the phenomena in question, as their explication would constitute a very valuable addition to the existing state of our electrical knowledge. Mec. Mag.

## Mechanics' Register.

### *Origin of Amber.* By H. R. Goppet.

This substance was found at Muskaur, in large quantity in fossil wood, belonging evidently to the genus Abus, and in other specimens very nearly allies to the genus Larix. They are all found in the brown coal formation. Amber likewise occurs in coniferous plants, associated with ferns in the coal of Wening-Rackvitz. Since, then, it appears that we already know four different species of tree which afford amber, (and the number would doubtless be increased by attentive investigation,) the probability seems to me to be rendered still stronger, *that amber is nothing else than an indurated resin derived from various trees of the family of the Coniferæ; which resin is found in a like condition in all zones, because its usual original depositories, viz. beds of brown coal, have been formed almost every where under similar circumstances.*

Edin. New Philos. Jour.

### *Sir Isaac Newton's Manuscripts..*

An erroneous statement having found its way into the newspapers, respecting the purchase of Sir Isaac Newton's MSS. by the Royal Society, we are authorized to state that it has no foundation whatever. In consequence of Sir David Brewster being at present engaged in a large work on the life, writings, and discoveries of Sir Isaac Newton, he was kindly permitted by the trustees of the Earl of Portsmouth to examine the valuable collection of MSS. at Hursbourne Park. With the assistance of H. A. W. Fellowes, Esq., the accomplished nephew of Lord Portsmouth, many interesting and important letters and papers were discovered, which not only throw much new light on the early life and studies of our immortal countryman, but tend to refute the groundless rumours respecting a temporary derangement of his mind in 1692, and to exalt, in the highest degree, his moral and intellectual character.—*Morn. Chron. June* 27.

Lon. & Ed. Philos. Mag.

## *New Waggon Steam Drag.*

Mr. Boydell, of Dee Cottage, near Chester, has invented a locomotive engine, which, when fixed to heavy waggons, &c., will propel them on common roads at a very rapid rate. It was exhibited on Tuesday, and elicited the strongest approbation from many scientific and practical men who witnessed the trial, and minutely examined the machinery. It is applicable to ploughs, which it propels with great ease and velocity.

Chester Courant.—Mec. Mag.

## *Paris and Brussels Railway.*

The railway which has long been projected for uniting the capitals of France and Belgium, at length bids fair to be commenced in good earnest. The king of the French has just granted to Mr. John Cockerell, the celebrated English iron master of Leige, the "concession" of the railway for fifty years. The French government is to advance 25 per cent. of the cost, on the distance from Paris to the Belgian frontier; and Mr. Cockerill is to be entitled to all tolls and profits for the first half century, when, it is to be presumed, the works will become the property of the nation. The only condition with which the grant is accompanied, is, that the toll for the French portion of the railroad shall never exceed *fifteen* francs, or 12*s*. 6*d*. The terms of concession were not agreed to until after the " high contracting parties," Louis Philippe on one side, and Mr. Cockerill on the other, had had several personal interviews. The latter must be allowed to possess a most adventurous spirit; he was a severe sufferer by the revolution at Brussels in 1830; and yet, it seems, is not deterred from adventuring his capital on a soil like that of France, which in fifty years may experience, probably, half as many revolutions.

Mec. Mag.

## *The Thermo-electric Spark, obtained from a single pair of Metallic Elements.*

### *By* Mr. Francis Watkins.

With a pair of metallic elements, consisting of one bismuth and one antimony, weighing each five grains, and measuring 0.5 of an inch long, and 0.12 diameter, when their extremities were unequally heated, I have obtained, with a Henry's flat ribbon coil, a very perceptible and brilliant spark.

Now I have pen in hand, permit me to state that with thermo-piles I actuate most of the apparatus usually employed for illustrating electromagnetic phænomena, so that the public teacher may now show by the same apparatus the several rotations, &c., with thermo-electricity, as he does with voltaic electricity. Lon. & Ed. Philos. Mag.

## *Celestial Phenomena for March* 1838.

| LUNAR OCCULTATIONS FOR PHILADELPHIA, JANUARY 1838. | | | | | Angles reckoned to the right or westward round the circle, as seen in an inverting telescope. ☞ For direct vision add 180° ☜ | |
|---|---|---|---|---|---|---|
| Day. | H'r. | Min. | Star's name. | Mag. | from Moon's North point. | from Moon's Vertex. |
| 4 | 10 | 0 | Im. of *c* Aurigæ | ,6, | 64° | 123° |
| 4 | 11 | 16 | Em. ‘ | | 272 | 333 |

## *Meteorological Observations for October*, 1837.

| Moon. | Days. | Therm. | | Barometer | | Wind. | | Water fallen in rain. | State of the weather, and Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | Sun rise. | 2 P.M. | Sun rise. | 2 P.M | Direction. | Force. | | |
| | | | | Inches | Inches | | | Inches. | |
| | 1 | 60° | 69° | 29.84 | 29.84 | W. | Moderate. | | Clear—do. |
| | 2 | 54 | 71 | 29.95 | 29.90 | W. | do. | | Clear—lightly cloudy. |
| | 3 | 55 | 64 | 29.96 | 30.0[illegible] | W. | do. | | Partially cloudy—do. do. |
| | 4 | 46 | 54 | 30 10 | 30.15 | W. | do. | | Cloudy—clear. |
| | 5 | 36 | 57 | 30.20 | 30.00 | S. | Brisk. | .7 | Clear—frost—cloudy—rain. |
| | 6 | 52 | 56 | 29.80 | 29.80 | N. | do. | .24 | Partially cloudy—rain. |
| ☾ | 7 | 40 | 58 | 29.95 | 29.97 | W. | Moderate. | | Clear—partially cloudy. |
| | 8 | 45 | 54 | 29.97 | 30.10 | NE. | Brisk. | | Partially cloudy—do. do. |
| | 9 | 36 | 51 | 30.35 | 30.40 | NE. | do. | | Partially cloudy—cloudy. |
| | 10 | 46 | 64 | 30.26 | 30.14 | NE. | Moderate. | | Cloudy—do. |
| | 11 | 51 | 70 | 30. 5 | 30. 5 | W. | do. | | Clear—do. |
| | 12 | 55 | 72 | 30. 5 | 29.90 | W. | Brisk. | | Partially cloudy.—do. |
| | 13 | 42 | 44 | 29.80 | 30. 5 | NE.NW. | do. | .16 | Rain—do. |
| ☉ | 14 | 30 | 60 | 30.25 | 30.20 | NW. | do. | | Clear—do. |
| | 15 | 36 | 59 | 30.20 | 30.2[illegible] | W. | Moderate. | | Clear—do. |
| | 16 | 50 | 62 | 30.10 | 30.15 | W.NW. | do. | | Partially cloudy—do. do. |
| | 17 | 45 | 64 | 30 31 | 30.22 | W. | Calm. | | Clear—cloudy. |
| | 18 | 54 | 56 | 30.00 | 30.00 | SW. | do. | | Cloudy—clear. |
| | 19 | 57 | 70 | 29.80 | 29.90 | W.E. | Moderate. | | Clear—do. |
| | 20 | 55 | 66 | 29.85 | 29.70 | SE. | Brisk. | .2 | Cloudy—rain. |
| ☽ | 21 | 48 | 58 | 29.86 | 29.95 | W. | do | | Cloudy—do. |
| | 22 | 44 | 63 | 30. 5 | 30. 5 | NE.SW. | Moderate. | | Partially cloudy—clear. |
| | 23 | 50 | 75 | 29.95 | 29.96 | W.S. | do. | | Clear—do |
| | 24 | 55 | 76 | 29.90 | 29.85 | W. | do. | | Fog—clear. |
| | 25 | 60 | 67 | 29.85 | 29.85 | SE. | do. | | Fog—cloudy. |
| | 26 | 56 | 59 | 29 84 | 29.85 | E. | Brisk. | | Cloudy—do. |
| | 27 | 45 | 49 | 29.84 | 29.86 | NE.NW. | do. | | Rain—cloudy. |
| | 28 | 36 | 50 | 29.95 | 29.95 | W. | do | | Clear—cloudy. |
| ⊗ | 29 | 32 | 42 | 30.00 | 3 .00 | NW. | Blustering. | | Coudy—clear |
| | 30 | 29 | 47 | 29.83 | 29.90 | NW. | Brisk. | | Cloudy—cloudy. |
| | 31 | 36 | 15 | 30.00 | 30.00 | NE. | Modrate. | | Clear—do. |
| | Mean | 46.45 | 59.93 | 29 99 | 29.99 | | | .49 | |

| | | Thermometer. | Barometer. |
|---|---|---|---|
| Maximum | height during the month | 76.00 on 24th. | 30.40 on 9th |
| Minimum | do. | 29.00 on 30th. | 29.70 on 20th |
| Mean | do. | 53.19 | 29.99 |

# JOURNAL

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# FRANKLIN INSTITUTE

OF THE

**State of Pennsylvania,**

AND

# MECHANICS' REGISTER.

FEBRUARY, 1838.

## Practical and Theoretical Mechanics and Chemistry.

### *On Hydraulic and Common Mortars. By General* TREUSSART, *Inspecteur du Genie. Translated from the French by J. G. Totten, Lt. Col. of Eng. and Brevet Col. United States Army.*

(CONTINUED FROM P. 35.)

ARTICLE VII.—*Various Experiments on Mortars placed under water.*

Much importance has been attached to the manner of slaking lime. Mr. Lafaye published in 1777, a memoir in which he gives, as a secret recovered from the Romans, the mode of slaking lime by plunging it into water for a few seconds, and then withdrawing it to slake and fall to powder in the air. This powdered lime is preserved in a covered place Other Engineers have asserted that there is great advantage in stifling lime as it slakes; that is to say, covering it with sand before it begins to slake, in order to retain the vapours liberated during the process. Mr. Fleuret attributes great efficacy to this vapour, for he says "This vapour awakens and excites the appetite of the workmen, whence I conclude that it contains principles proper to the regeneration of lime and consequently to the hardening of mortars. But it is proved that nothing escapes but the vapour of water accompanied by some particles of lime. I made, on this point, the experiments contained in the following table.

Table No. XXV.

| No. of the mortars. | Composition of the mortars. | No. of days required to harden in water. | Weight supported before breaking. |
|---|---|---|---|
| | | days. | lbs. |
| 1 | Obernai lime slaked to powder with 1-5 of its volume of water being left in the air . . 1<br>Sand . . . . . 2 } 3 | 15 | 176 |
| 2 | Lime the same, slaked to powder with 1-5 of its volume of water being covered with sand . . . 1<br>Sand . . . . 2 } 3 | 15 | 176 |
| 3 | Lime the same, slaked by being plunged in water for 50 seconds . 1<br>Sand . . . . 2 } 3 | 15 | 154 |

### *Observations on the Experiments of Table* No. XXV.

To make the three experiments above, I took a piece of Obernai lime which I divided into three portions. The first portion was slaked by throwing on one fifth of its volume of water, leaving the lime at rest in the air for twelve hours before making it into the mortar No. 1. The hardening was slow because the experiment was made in November.

No. 2 was slaked in the same manner with this difference, that I covered the lime with the sand as soon as I had thrown on the water. This, also, was left to itself for twelve hours before making it into mortar. These two experiments gave, we see, the same results.

The third experiment differs from the first in this, that to slake the lime, I plunged it into water for fifty seconds—afterwards treating it in the same manner as No. 1. The result was less by 22 lbs. It is singular that I got the same results, as will be seen further on, by making similar mortars and leaving them in the air, instead of placing them under water. The result, it seems to me, is owing to the lime, immersed for fifty seconds, absorbing too much water, which is hurtful, as the experiments in the following table will show. I purposed repeating the trial, by varying the time during which the lime should be immersed, but I had not an opportunity.

We have seen, in tables Nos. IV, V and VII, that the Obernai and Metz lime soon lose a great part of their properties, when they have been slaked to dry powder and left exposed for some time to the air. It is true that a piece of Obernai lime gave me, in this way, the most favourable result of table No. VI, but only in the first month after slaking: for, afterward, this lime rapidly lost its quality. We ought then, by no means to apply the process of Mr. Lafaye to hydraulic limes, unless assured of a different result from mine, which, I think, need not be looked for.

As to fat limes, table No XIV shows that when they were slaked to powder, and left in this state, in the air, for a couple of months, I obtained, by mixing this lime with trass, results sensibly better than when I used lime just slaked. I think, therefore, that it is best to slake fat limes to powder and to leave them for a month or two in this state in the air, before using them in mixture with hydraulic cements; but the process of Mr. Lafaye may be much simplified, by throwing on the lime a quarter, or a third, of its volume of water: it was in this way that I operated; avoiding, thereby, the embarrassment of panniers or baskets. We have seen, above, that lime slaked to powder has the property of absorbing oxygen; and it is to that property I attribute the benefit derived from leaving lime exposed to the air after being slaked to powder. Table No. XV offers a similar result; but as the proportions were not the same, I do not know which of the two modes is preferable—slaking fat lime to powder, or reducing it at once to paste.* We see that in both cases, there is an advantage in not making the mortars immediately. If time had been allowed me I should have repeated these experiments; making the proportions the same. It sometimes happens that hydraulic lime has been wet, either in the lime house from carelessness, or out of doors, when slaked and covered with sand. I accordingly made the following experiments with lime slaked with more than the usual quantity of water—making mortars therewith at different periods.

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* Comparing the series of Nos. 1 and 3 of table No. XV, we see that at the end of six months, lime slaked to powder supported 44 lbs. more than that slaked to paste. but in the following mortars, the advantage was only 11 lbs. which is but trifling. Au.

## Table No. XXVI.

| Composition of the mortar. | Made immediately. | | After 12 hours. | | After 24 hours. | | After 36 hours. | | After 48 hours. | | After 60 hours. | | After 72 hours. | | After 84 hours. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | H | W | H | W | H | W | H | W | H | W | H | W | H | W | H | W |
| | d. | lb. | d. | lb. | d | lb. | d. | lb. | d. | lb. | d. | lb. | d. | lb. | d. | lb. |
| Obernai lime slaked to humid powder with a volume of water equal to the volume of lime measured in powder . . 1<br>Sand . . 2 } 3 | 15 | 242 | 16 | 209 | 20 | 165 | 22 | 132 | 24 | 121 | 26 | 97 | 30 | 77 | 32 | 66 |

### *Observations on the experiments of Table* No. XXVI.

To make the above experiments I took Obernai lime fresh from the kiln, and slaked it by throwing on a bulk of water equal to the bulk of lime: thus slaked, it was in the state of powder, but on pressing it between the fingers it was felt to be a little moist. I made at once, a mortar, taking one part of this lime in powder, and two parts of sand; and I put it in water, after having left it for twelve hours in the air: I made other mortars in the same way, every twelve hours, and at the end of a year, I broke them all. The table shows that after twelve hours the mortar had already lost much of its force, since the second mortar supported 33 lbs. less than the first. That which was made after twenty-four hours lost 77 lbs., and at the end of thirty-six hours, this lime gave a mortar that had lost almost half its force. The table shows that the strength of these mortars went on diminishing in a very rapid manner, to the last, which being made after eighty-four hours, supported only 66 lbs., in lieu of the 242 lbs. which the same lime sustained at first. We see also, that the rate of hardening decreased in a very rapid manner. These experiments show how dangerous it would be to slake hydraulic lime with too much water, and how important it is to keep it from the rain. In the experiments I have made, I almost always slaked hydraulic lime with one-fifth of its volume of water, and fat lime with one-fourth; because, as we have seen in the first table, the latter absorbs more water than hydraulic lime, before being reduced to paste. But in slaking on a large scale, the workmen always waste a portion of the water on the ground: there will therefore be no disadvantage in slaking hydraulic lime with one-fourth, and common lime with one-third of its bulk of water.

The experiments in the above table explain why mortar No. 3 of table No. XXV gave a result inferior to the others: the reason is, probably, because during the fifty seconds that the lime was plunged in water it absorbed too great a quantity; and as it remained twelve hours exposed to the air, it lost part of its strength. I will now give some experiments that I made in in order to ascertain the influence of different quantities of trass on the qualities of mortars.

## Table No. XXVII.

| No. of mortars. | Composition of the mortars. | | | No. of days required to harden in water. | Weight supported before breaking. |
|---|---|---|---|---|---|
| | | | | days. | lbs. |
| 1 | Fat lime slaked to powder and measured in powder | 1 | 2¼ | 19 | 103 |
| | Sand | 1 | | | |
| | Trass | ¼ | | | |
| 2 | Lime the same | 1 | 2½ | 15 | 163 |
| | Sand | 1 | | | |
| | Trass | ½ | | | |
| 3 | Lime the same | 1 | 2¾ | 10 | 216 |
| | Sand | 1 | | | |
| | Trass | ¾ | | | |
| 4 | Lime the same | 1 | 3 | 8 | 301 |
| | Sand | 1 | | | |
| | Trass | 1 | | | |

### *Observations on the experiments of Table* No. XXVII.

We see that in the above experiments I first used a very small quantity of trass, and that I augmented it little by little. No. 2, containing very little trass, gave a result superior to many mortars made of natural or artificial hydraulic limes: such a mortar would not be dear, and might be employed with advantage in gross masonry.

I made no experiments to determine the quantity of sand or factitious puzzalona that would suit the hydraulic and fat lime, of the neighborhood of Strasburg, because I think these experiments should not be made on a small scale. We have seen that the same quarry furnishes limestone giving different results. A multitude of essays, on several pieces of lime calcined to different degrees, would have been necessary, which would have demanded much time. Instead of following this course, I proposed, (after getting some facts as to proportions from the above experiments) to take mortar already made at the works, the lime being there slaked in large quantities at a time: repeating this several times, I should have determined the quantity of sand and hydraulic cement which it would be proper to mix with the lime used at the works: but I quitted Strasburg before it was in my power to make these experiments. There was used at that place, as I have before stated, one part of quick lime (measured as quick lime) to two and a half of sand: the mortar was good; as there was occasion to ascertain in several partial demolitions.

Mr. Raucourt has advanced the opinion that sands require different quantities of lime according to their degree of coarseness; and to know the quantity of lime, it will suffice to measure the void spaces between the particles of sand, these void spaces being the measure of the lime. Accordingly, he filled a vessel, successively, with several kinds of sand and determined the quantity of water which could be poured on each without overflowing the vessel, whence he obtained for each the quantity of lime that should be added. But experiments should be made to ascertain whether the best mortar is obtained when these voids in the sand are just filled with lime; this Mr. Raucourt has not ascertained.

Before the publication of Mr. Raucourt's work, Captain Henry Soleirol of the Engineers, had engaged in researches of the same sort. Capt Soleirol, also, thinks that no more lime should be added than will fill these void spaces in the sand. But his experiments presented anomalies difficult to explain; and they are not sufficient to cause us to admit the principle, in anticipation. This theory is ingenious, but it wants, as yet, the support of facts. The subject is important and deserves to occupy the leisure of Engineers.

The next table presents several experiments made with fat lime in reference to the manipulation of mortars.

### Table No. XXVIII.

| No. of the mortars. | Composition of the mortars. | No. of days required to harden in water. | Weight supported before breaking. |
|---|---|---|---|
| | | days. | lbs. |
| 1 | Mortar in equal parts of fat lime, sand and trass, put in water immediately . . | 18 | 290 |
| 2 | Same mortar put in water after having been left twelve hours without being reworked . | 13 | 328 |
| 3 | Same mortar reworked, after twelve hours, without water—and put in water twelve hours afterward . . . . | 13 | 330 |
| 4 | Same mortar reworked, after twelve hours, with a little water, and put in water twelve hours afterward . . . . | 15 | 326 |
| 5 | Same mortar, put in water after twenty-four hours —without being reworked . . | 12 | 308 |
| 6 | Same mortar reworked after twenty-four hours with a little water, and put in water twelve hours afterward . . . | 15 | 363 |
| 7 | Same mortar, put in water after thirty-six hours without being reworked . . | 12 | 319 |
| 8 | Same mortar, reworked after thirty-six hours with a little water, and put in water twelve hours afterward . . . | 15 | 363 |
| 9 | Same mortar, put in water after forty-eight hours without being reworked . . | 12 | 319 |
| 10 | Same mortar, reworked with a little water, after forty eight hours, and put in water twelve hours afterward . . | 15 | 330 |
| 11 | Same mortar put in water after sixty hours without being reworked . . | 12 | 308 |
| 12 | Mortar of one part of Obernai lime and two parts of sand, put in water immediately . | 15 | 154 |
| 13 | Same mortar put in water after twelve hours exposure without being reworked . | 15 | 165 |
| 14 | Same mortar, reworked with a little water after twelve hours, and put in water twelve hours afterward . . . | 12 | 198 |
| 15 | Mortar of Obernai lime, sand and trass in equal parts, put immediately in water . | 4 | 405 |
| 16 | Same mortar reworked with a little water after twelve hours, and put in water twelve hours afterward . . . | 3 | 528 |

### *Observations on the experiments of Table* No. XXVIII.

It often happens that a good deal of mortar is prepared and that bad weather for a day or two prevents the workmen from using it. If it be hydraulic mortar, it becomes hard in the interval of a day, and often of a night, and it would be impossible to use it in that state. By reworking it for a long time, it might be brought to the proper consistence without any addition of water, but this is expensive: it is better to bring it to proper consistence by reworking it for a short time with a little water. Many Engineers think that mortar is improved by being worked several times a day: they consequently often make mortars several days before hand—work it well at first, and permitting it to stiffen, bring it again to proper condition by reworking, because, say they, *good mortars must be tempered with the sweat of the Labourer*: but the sweat of the Labourer costs money, which it is important to save. These considerations induced me to make the above experiments.

The first eleven mortars were composed of fat lime, sand and trass in equal portions. No. 1 was put in water immediately, while No. 2 was left twelve hours in the air, and then put in water without being reworked. This last we see gave a resistance sensibly greater than the first. Nos. 3, 4 and 5 remained twenty-four hours in the air before being put in water; No. 3 was reworked, twelve times, without water, No. 4 was reworked with water, and No. 5 was not reworked. It is important to remark that the results of No. 3 and 4 are very nearly the same as No. 2—No. 5 supported a weight sensibly less than No. 4.

After twenty four hours, it was not possible to rework these mortars without adding a little water. In consequence, Nos. 6 and 7 were put in water after thirty-six hours: with this difference between them, that No. 6 was reworked with a little water, while No. 7 was not reworked, No. 6, we see, gave a result decidedly better than No. 7.

Nos. 8, 9, 10 and 11, were made in the same way, and gave better results with those mortars that had been reworked with a little water, than with those that had not been reworked; at the end of sixty hours the resistance began to diminish.

If we compare Nos. 4 and 5, 6 and 7, 8 and 9, 10 and 11, which were left in the air, we shall see that those which were reworked with a little water, gave greater resistance than those which were not reworked.

If we compare Nos. 2 and 3, we see that this last mortar gained very little by being reworked, although it was worked over twelve different times. An excess of trituration, therefore, seems useless; for three or four pounds, more or less, of resistance, is almost nothing, when the mortars support 330 lbs.

Nos. 12, 13 and 14, were made with hydraulic lime and sand. The first two gave about an equal resistance; No. 14, which was reworked with a little water, was much the best of the three.

Lastly, Nos. 15 and 16, were composed of Obernai lime, sand and trass; No. 15 was put immediately in water. No. 16 was not put in until it had been worked with a little water. The latter gave a result much superior to the former.

I ought to mention that when the mortars had taken a slight consistence in the air, I always compressed them gently with the trowel before putting them in water; but Nos. 1 and 15 having been plunged into water as soon as made, were not compressed, while Nos. 4 and 16 were. I cannot think that so slight a compression has made so great a difference. We see besides that there is but little difference between Nos. 12 and 13, although this last had been compressed, while No. 14, which had been reworked with water, afforded a resistance much greater.

The mortars Nos. 12, 13 and 14, ought not to be compared with Nos.

15 and 16, first, because the last two contain trass, and, secondly, because the two limes were of different burnings. It results from the table, that when we have hydraulic mortar, composed of fat lime, sand and trass, or of hydraulic lime and sand, or mixed with trass; in either case, there is no disadvantage in reworking with a little water, when, from any circumstances, it has become too dry to be used. There is even an advantage in doing it; thus, in making mortar at night, and in the morning giving it a little water, and, by a little work, bringing it to its first condition, the mortar can only be improved thereby; but an excess of trituration is useless—not augmenting the strength of the mortar in comparison with the increase of expense. The following table contains several other experiments which I made on mortars.

Table No. XXIX.

| No. of the mortars | Composition of the mortars. | No. of days required to harden in water. | Weights supported before breaking. |
|---|---|---|---|
| | | Days. | lbs. |
| 1 | Mortar of one part of fat lime and two parts of trass | 4 | 462 |
| 2 | Same mortar with the same trass wet - | 4 | 451 |
| 3 | Same mortar with the same trass not so fine as No. 1 | 6 | 231 |
| 4 | Mortar made of 1 part of Obernai lime and 2 parts of sand, put in the water at the end of 12 hours, without being reworked . . . | 10 | 231 |
| 5 | Same mortar, reworked after 12 hours, and put in water 12 hours afterward . . . | 10 | 220 |
| 6 | Mortar of 1 part of Obernai lime and 2 parts of sand tempered thin - . . . . | 10 | 176 |
| 7 | Same mortar—tempered stiff . . . | 10 | 161 |
| 8 | Mortar of 1 part of fat lime half burnt and 2 parts of sand . . . . . . | | |
| 9 | Mortar of 1 part of Obernai lime and 2 parts of sand | 12 | 110 |
| 10 | Same mortar with the sand broken fine . | 10 | 253 |
| 11 | Mortar of 1 part of Obernai lime and 2 parts of earthy sand . . . . . . | 15 | 132 |
| 12 | Same mortar, with the same sand after being washed | 8 | 231 |

### *Observations on the experiments of Table* No. XXIX.

The first experiment was made with ordinary trass which had been sifted through a fine hair seive; it was thus that I used it in all my experiments. No. 2 was made of the same trass which I had left during a month at the bottom of a vessel wherein it was covered with water. Several constructors think it necessary to keep trass from moisture; this experiment proves there is nothing to fear from water. There is no disadvantage in leaving the pieces of trass, or of burnt clay of which artificial trass is made, exposed. But, when in a state of powder, it is necessary to keep it covered from winds.

No. 3 was made of the same trass which had been passed through a much coarser seive. The result, as we see, was inferior, by one half, which is not surprising, as I shall show in the sequel. It appears that it is important that trass and hydraulic cements be finely pulverized: there should be no perceptible asperities on taking the substance between the fingers. The two experiments Nos. 4 and 5, have the same object as the preceding table; they were made from lime of another burning. No. 4 was put in water after twelve hours exposure in the air, without being reworked. No. 5 was reworked without water after twelve hours, and put in water twelve hours afterward. If there is any advantage, it is rather in favor of the mortar which was not reworked; but such slight differences may be regarded as nothing. We can conclude only, that when hydraulic mortars have been well mixed, which is the case when they appear homogeneous to the eye, nothing will be gained by any further labour. But we have seen by the preceding experiments, that if, after having left mortars at rest for some time, they be worked up anew with a little added water, increased force will be given to them. Nos. 6 and 7 were made with the same Obernai lime. Both were left in the air for twelve hours before being put in water, and all other circumstances were the same. The only difference being, that No. 6 was made into thin, and No. 7 into stiff mortar. There is a sensible difference in the resistances: and that both are feeble, must be ascribed to their being both made of a piece of inferior lime. The result is in opposition to the opinion of Mr. Vicat, for at the conclusion of a note that he wrote on the first experiments that I published, he says: "Mr. Treussart affirms, as respects the manipulation, that mortars tempered to ordinary consistency, that is to say, soft, are better than stiff mortars. This implies a contradiction, not only of facts generally observed up to this time, but also, in a measure, of the observations of the author himself."

I announced these results in 1823, because they are important in the manipulation of mortars, and were furnished by my experiments. I am fully aware they are in opposition to the opinion generally received; but I do not see in what they are opposed to my own observations, nor does Mr. Vicat inform us. They, on the contrary, coincide with all that precedes.

We have seen, in fact, that mortars gain sensibly, after they have somewhat hardened, by reworking them with a little water. We have also seen, at the commencement of this memoir, that fat quick lime, reduced to thin paste with water, is capable, for a long time, of absorbing fresh quantities of water. Is it not probable then that it is the same with hydraulic lime? When it has been reduced in paste to the consistence of common mortar, it is possible that it may not yet have absorbed all the water necessary to convert it into the best mortar. It is possible that a mass of mortar put in water, may absorb but a small quantity in consequence of its prompt induration. If so, it is not astonishing that a new quantity of water added to a mortar, after it has absorbed the first—or that a mortar made more fluid at first, should give the best results. The question is important, because it is much easier to mix mortars when they are thin than when they are stiff; and there results, consequently, a considerable saving. I was bound to give the results obtained with Obernai lime, in order to draw attention to them, and engage constructors using those sorts of lime, to experiment on the subject. All the mortars made at Strasburg, whether for works in water or air, were made of the consistence of common mortars, and very often, when, from any cause, they had somewhat stiffened, they were worked up anew with a little water, and we always had very good results.

Experiment No. 8 was made to verify an important fact announced by Mr. Minard, Engineer of Roads and Bridges. He states that by burning the lime feebly, so as to leave a portion of the carbonic acid in the lime stone after burning, a very good hydraulic lime will be obtained. I, in consequence, repeated his experiment, taking a piece of fat lime stone and placing it in the kiln above the tiles, so as to burn it but partially. I satisfied myself, by testing with muriatic acid, that, after this feeble burning, the piece of lime still contained much carbonic acid: but it had also lost so great a portion, that on throwing water on it, it was reduced to powder. I made mortar with this lime—mixing it with sand, and put it in water;

but we see that I obtained no result: at the end of a year the mortar was entirely soft.

Experiment No. 9 was made with the same lime and sand as experiment No. 10; the only difference being that No. 9 was made with common sand in its natural state, and No. 10 with the same sand after it had been broken up very fine. Both mortars were composed of one part of lime in paste to two and a half parts of sand. Many constructors think that coarse sand is preferable for gross masonry. We see, however, that the resistance I obtained with common sand, not coarse, was only 110 lbs., while that given by mortar made of the same sand after it had been pulverized, was 253 lbs. I confess that this result surprised me greatly. When I made these two mortars, which were put in water, I made two others of the same kind which I left in the air. We shall see, in the second section, that the mortar made of common sand broke under a weight of 187 lbs., while that which was made of the pulverized sand supported 275 lbs., although it was cracked. Commonly, the mortars put in water have given me, when made of hydraulic lime, better results than those left in the air. I am induced, therefore, to think that No. 9 gave a result so feeble in consequence of some circumstance that escaped notice. It is possible that the mortar was cracked without my perceiving it; and it, therefore, as yet, appears to me doubtful whether there can be so great an advantage, as I find in these two experiments, in making mortar of fine sand; although it seems certain that there is an advantage in the case of hydraulic limes, in making mortar of fine sand. Mr. Vicat obtained a similar result, as we see by his table No. XVI.

No. 11 was made of one part of fat lime in paste to two parts of an unwashed, earthy sand used at Phalsburg. No. 12 was made of the same lime and the same sand cleared of the earthy matter by washing. The washed sand gave me a result almost double that afforded by the earthy sand. It is therefore very important to use clean sand.

We find in vol. VII, of the *Annales des Mines* a discussion between Mr. Vicat and Mr. Berthier, as to the cause of the solidification of mortars. Mr. Vicat attributed it to the chemical action exercised by the lime on the siliceous matter. Dr. John, on the contrary, had established in principle, that the substances mixed with lime to make mortars, and which he denominates alloys, *(alliages,)* are altogether passive. He relates that, according to his experiments, caustic lime attaches neither quartz, nor any other stony substance. Mr. Berthier, who has examined this question, says, "I think, with Mr. John, that the alloys perform no chemical part in mortars; these alloys appear to me to have the effect, 1st, of diminishing the consumption of lime; 2d, of regulating the shrinkage, by moderating it, making it uniform and preventing cracks; 3d, probably, of facilitating dessication and the regeneration of carbonate of lime, and hastening the induration; 4th, of augmenting the solidity of mortars." According to Mr. Berthier, the molecules of the alloy contract with the molecules of the lime an adherence more or less strong. If this adherence be less than that which unites the molecules of lime to each other, the mortar will not be more solid than was the pure hydrate: it will, however, cost less, it will harden quicker, and will be less subject to crack in drying, which is of itself a great advantage. But if the force of adhesion of the lime be less than the force with which it adheres to the alloy, we may conceive that the mortar may acquire more tenacity than the pure hydrate; and this is, probably, what takes place in mortars.

Other philosophers, and several engineers, have thought that the solidification of mortars was owing to the lime passing again to the state of carbonate, by absorbing carbonic acid from the air. This opinion cannot, however, be sustained; for we know that carbonic acid penetrates only very slowly into the portion of hydrate of lime which is exposed to the air. Very large masses of mortar, plunged into water, will sometimes acquire complete hardness in three or four days, while other mortars containing the same quantity of lime, and placed in the same circumstances, often take more than a month to indurate. Mr. Darcet analysed the mortar from the Bastile, and found the lime had only half the carbonic acid required to saturate it. Mr. John analysed several ancient mortars that were very hard, and found a much smaller proportion of carbonic acid. Besides, it by no means follows that all the carbonic acid found in old mortars, has been absorbed by the lime: for we know from experience that it is difficult to disengage all the carbonic acid from lime by calcination. The lime we use in our constructions often contains a great deal; and it is not, therefore, surprising that the analyses of old mortars show a great difference in this respect. The following, moreover, is a proof that the absorption of carbonic acid has no influence on the induration of mortars, at least in the beginning. I took hydraulic lime and reduced it to the state of hydrate with distilled water, making a rather thick paste, which I placed at the bottom of a phial; I then filled the phial with distilled water and corked it tightly; and when the lime was so much stiffened as not to run, I inverted the bottle, (still corked,) placing the mouth in a vessel full of water. I repeated the experiment with mortar made of hydraulic lime and sand, and with another mortar of fat lime and trass. These three substances hardened as quickly as if they had been put in water which was in contact with the air. Being deprived of all communication with the air, we cannot ascribe the hardening to carbonic acid. The surface of several old mortars exposed to the air has been observed to have passed to the state of carbonate; but only for a small depth, and it requires several centuries to produce even this change. The induration of mortars cannot, therefore, be attributed to the regeneration of carbonate of lime.

The reasons given by Mr. Vicat, and Mr. Berthier, on the question whether there is, or is not, a combination of lime with the substances united with it to form mortars, not appearing to me to be conclusive, I shall offer my own opinion on this subject, so important as regards the theory—presenting some facts in support of my views.

To account for the solidification of mortars in water, it seems to be necessary to divide them into two distinct classes; those composed of hydraulic lime and sand, and those composed of fat lime and puzzalona, or some analagous substance. As to mortars made of hydraulic lime and sand, it is not at all necessary to suppose that there is a chemical combination between those two substances, for we have seen by the first tables that the hydraulic limes, alone, when they are reduced to paste, harden promptly in water without it being necessary to mix any substance with them. We might be led to believe that there was a combination between hydraulic lime and sand by experiments Nos. 9 and 10, of table No. XXIX, which prove that the strongest resistance is given by fine sand; but, on the other hand, the facts cited by Mr. John, who found that sand was not attached by quick lime, and the reasons given by Mr. Berthier, lead to the belief that there is no such combination. To explain the hardening of mortars made of hydraulic lime, it is not necessary to suppose that it combines with the sand, since this lime hardens when alone in the water. It remains then to explain why hydraulic lime, itself, should harden in water. I will observe, on this point, that this particular lime is a combination of lime and a certain quantity of argil, by means of calcination; it is a substance, therefore, altogether different from lime, and it has acquired new properties that the lime had not: lime dissolves in water, while good hydraulic lime does not.

We know that when we mix, in certain proportions, soda, or potash, which are opaque, and soluble in water, with silex, which is also opaque, and heat the mixture, we obtain a new substance, which is transparent and insoluble in water, and which is called glass. It is not, therefore, astonishing that lime mixed with a little clay and heated, should produce a new substance that will harden in water, while lime alone will remain soft. Although we give to this compound the name of hydraulic lime, it ought, in fact, to be regarded as a substance altogether different from lime; it is a new body with new properties.

As to hydraulic mortars made of fat lime and puzzalona, or other analagous substance, I do not see that the hardening in water can be explained without supposing a combination between the fat lime and the puzzalona; for this lime, put alone in water, or mixed with sand, remains always soft. To prove the truth of this explanation, I made the following experiment: I took a mortar composed of one part of lime made from white marble, and two parts of puzzalona, which mortar had been one year in water. From the centre of this mortar I took a piece which I reduced to very fine powder, putting the powder in a vessel which I then filled with distilled water. But we know that if fat lime be put in water, the water will dissolve $\frac{1}{400}$ of its weight in a few minutes. Nevertheless, after twenty-four hours, the distilled water had no portion of the lime. I satisfied myself, on the other hand, that the lime of the mortar had not passed to the state of carbonate: because, on throwing muriatic acid on the powdered mortar, there was very little effervescence. The lime had not therefore passed to the state of carbonate, and still it would not dissolve in water, which could only proceed from its state of combination with the puzzalona.

I communicated this fact nearly two years ago to Mr. Berthier, giving him a little of the pulverized mortar which I used in my experiment, and he obtained the same result that I did. I will add that I made some hydraulic mortar by mixing one part of fat lime measured in paste, with two parts of puzzalona; one portion of this mortar I placed at the bottom of a glass, and covered it immediately with water; the other portion was also placed in the bottom of a glass, but was not covered with water till after the lapse of twelve hours. A strong pellicle of carbonate of lime formed all over the surface of the water which had been put on the fresh made mortar, while in the case of the mortar that had been twelve hours in the air before being covered, there was only a light pellicle of carbonate of lime on portions of the surface of the water; more than half the surface of the water was without any pellicle. This experiment proves that lime combines very promptly with puzzalona.

The hardening of hydraulic mortars in water may be explained, then, in the following manner: if the mortar be made of hydraulic lime and sand, this last substance appears to be in a passive state; the induration of mortar takes place because hydraulic lime hardens of itself in water—this being a property resulting from the state of combination of a small quantity of clay with the lime. If the proportion of lime be too much forced, a good hydraulic lime will no longer be obtained. A similar effect occurs in making glass: if the quantity of soda or potash be too much forced, the result is nearly a deliquescent compound. When hydraulic lime is made of fat lime and puzzalona, the hardening takes place because there is brought about a combination of fat lime and puzzalona in the moist way. In this case—that the combination may work well, it is requisite that the puzzalona be in greater proportion than the lime.

There is always a reduction of volume, in making mortars, on the mingling of the constituents. I have endeavored to measure this diminution by experiments on a large scale. First, four heaps, composed each, of 10.60 cubic feet of Obernai quick lime, and 21.20 cubic feet of sand—making altogether 127.20 cubic feet, became reduced by manipulation to 101.71 cubic feet of mortar of ordinary consistence: the volume diminished therefore in the ratio of 1.00 to 0.80—that is to say, was lessened 0.20. In a second experiment, fifty eight heaps,* composed each of 10.602 cubic feet of quick lime, and 26.505 cubic feet of sand, forming together a volume of 2152.21 cubic feet, produced 1779.955 cubic feet of mortar. The primitive volume diminished, therefore, in the ratio of 1.00 to 0.822—that is to say, was lessened 0.178. According to the first experiment, the reduction was one fifth: and in the second, where there was more sand, it was about one sixth. These facts will be useful in making analyses, to determine prices.

Mr. Lacordaire, Engineer of Roads and Bridges, engaged on the canal of Bourgogne, has announced that he has obtained good hydraulic mortars by the following means. He burnt hydraulic lime stone but partially, and slaked it by immersion. The portions the most burned fell to powder; and the lime thus furnished he used by mixing it with sand, and with the portion of the lime stone that did not slake; which portion he pulverized and used as a cement. There has been established, at Pouilly, a manufactory of this substance, to which the name of Pouilly cement has been given; and as a cement, it is mixed with fat lime. We see that Mr. Lacordaire has applied to hydraulic lime, a process analagous to that which Mr. Minard proposed for fat lime stone, and which in our trials gave no results, as may be seen page 80.

I procured two specimens of the hydraulic lime stone of Pouilly, and also a piece of the half burnt lime of which the cement of that name is made. One of these lime stones is a distinct blue, and the other of an ash colour. The piece of half burnt lime was of a brown colour, and had been out of the kiln about six months. I made with this half burnt lime the following essays: I detached a piece on which I poured water; there was no heat given out, and it did not fall to powder. I then put a piece in muriatic acid diluted with a little water; there was considerable disengagement of carbonic acid, and it dissolved, leaving a residue of about one fifth, which was clay mixed with a little red oxide of iron. I reduced the piece still left, to a very fine powder, and made therewith the following experiments: I first mixed one part of fat lime measured in paste, with two parts of this powder. After having well mixed the whole with a little water, to bring it to the consistence of sirup, I placed it in the bottom of a glass. One hour afterward I was obliged to cover it with water, because it became consistent. Twelve hours after being covered with water, it was completely hard. I made a second experiment by reducing the powder, alone, to paste with water, and in an hour after being placed in the bottom of a glass, it was covered with water; at the end of twelve hours the induration of this, also,

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*In the original, it is 52 heaps, which must be a misprint, as it requires 58 heaps to make up the quantity of 2152.21 cubic feet.—*Trans.*

was complete. Lastly, I made a third experiment with one part of fat lime and two parts of this powder, as in the first essay; but I added no more water than was requisite to reduce the mixture to a thick paste, and I left it in the air; it hardened with as much promptitude as plaster of Paris: and fifteen days afterwards it appeared to possess very great hardness. It will be possible, perhaps, to substitute this substance for plaster advantageously.

It results from the essays just given, that this matter reduced to paste with a little water, hardens in water, and in the air, with great promptitude; and that, employed in powder with fat lime, in the manner of puzzalonas, an equally prompt hardening is obtained. It appears to me that the name *cement* given to this substance is not suitable; for it is, really, a subcarbonate of hydraulic lime, that is to say, an hydraulic lime but little burnt, and containing, consequently, much carbonic acid. I may here observe that if we mix one part of fat lime with two parts of good hydraulic lime reduced to powder, this mixture will, equally, harden in water, without our being authorized to say that this powdered hydraulic lime is *cement*. This name belongs only to the powder of burnt clays; it is possible, however, that usage will preserve to this substance the name of cement, since it is used in the same manner as cement.

The fine observation of Mr. Lacordaire opens a new field as to hydraulic mortars. It will be very important to ascertain the tenacity of this substance; for we have seen by the Boulogne pebbles, and by several other mortars, that those which harden very quickly do not offer a great resistance. We have seen by table No. III, that several hydraulic limes, well burned and reduced to paste with water, have given, alone, greater resistance than when mixed with sand. The great promptitude of induration of these slightly burned limes merits particular attention. To judge accurately of this new mode of employing hydraulic limes, it will be necessary to make comparative experiments, first of the same lime stones, both slightly burned and thoroughly burned, made into paste with water; afterward by mixing them with a great quantity of sand; lastly, the lime but slightly burned should be used as cement with fat lime and with hydraulic lime, and with each of these kinds of lime united to sand. The hardening of the several mixtures should be compared; and at the end of a year they should be submitted to rupture, to determine their tenacity. Supposing that one part of fat lime, mixed with two parts of lightly burned hydraulic lime used as cement, should give a resistance equal to that afforded by mortar composed of the same hydraulic lime well burned and two parts of sand, it will then be necessary to examine which of these two processes is the cheapest.

In the first case lime only, which is a dear substance, is used; but the hydraulic lime, which composes two-thirds of the mortar, being much less burned, requires less fuel, at the same time that it requires a good deal of labour to pulverize it. We see, then, that it is by comparing the expense, with the resistance, of mortars, that we can fix upon the process to be adopted. There are circumstances, undoubtedly, where it is important to secure a speedy induration; but in ordinary cases, there is no inconvenience in waiting eight or ten days to allow the concrete, or mortar, to take sufficient hardness. It is to be presumed that we shall, ere long, have experiments which will show us whether this new mode of employing hydraulic lime presents advantageous results, as respects the tenacity of mortars. In those places where good hydraulic lime is found, it is very important that the experiments, of which I have spoken, should be made.

I have said that the half burned lime which I used as cement, had been calcined for six months; and that I obtained, nevertheless a prompt induration. That might be owing to its being still a stone, and that the air could not penetrate to the interior. It will be important to ascertain whether this lime will preserve its energy thus long, when reduced to powder. It will be equally necessary to know if it be indifferent whether this lime be plunged in water as soon as it is burned; or if it be preferable to half burn the whole kiln, so that it shall receive no water until it comes to be mixed into mortar with thorough burned lime.

We find in the VII volume of the *Journal des Mines*, the analysis, made by Dr. John, of several old mortars; and by Mr. Berthier of several lime stones. I will terminate his article by the exposition of these analyses in the following tables.

*Analysis by Dr. John of several Mortars.*

| | Mortars in air. | | | | | | Hydraulic mortars. | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| Carbonic acid | 0.0600 | 0.0575 | 0.0175 | 0.0500 | 0.0900 | 0.1200 | 0.0050 | 0.0225 | 0.0225 |
| Lime in the state of carbonate | 0.0800 | 0.0781 | 0.0260 | 0.0663 | 0.1194 | 0.1591 | 0.0070 | 0.0295 | 0.0298 |
| Lime combined with other substances | 0.0170 | 0.0431 | 0.0665 | 0.0207 | 0.0322 | 0.0809 | 0.0305 | 0.0395 | 0.2977 |
| Combined silex | 0.0100 | 0.0115 | 0.0375 | 0.0125 | 0.0025 | 0.0025 | 0.0200 | 0.0035 | 0.0800 |
| Quartz and sand | 0.8000 | 0.8010 | 0.7850 | 0.8375 | 0.6884 | 0.5600 | 0.7750 | 0.8950 | 0.3500 |
| Alumine—oxide of iron | | | | | 0.0275 | 0.0275 | | | |
| Water . . | 0.0330 | 0.0088 | 0.0675 | 0.0130 | 0.0400 | 0.0500 | 0.1625 | 0.0100 | 0.2400 |
| | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 | 1.0000 |

1. Mortar one hundred years old, from the exterior joints of St. Peter's, at Berlin.

2. Mortar a hundred years old from the interior joints of the same church.

3. Mortars six hundred years old, from a covered (*encombrée*) foundation of the same church.

4. Mortar six hundred years old, from the walls of the Cathedral of Brandeburg.

5. Roman mortar, from the wall of a tower built at Cologne under Agrippa in the first century of the Christian era.

6. Roman mortar from a tower built by Agrippa.

It appears that in these last two mortars the portion of lime not saturated with carbonic acid is combined with the alumine.

7. Mortar three hundred years old, from the outside wall of the old castle of Berlin.

8. Old Roman, hydraulic mortar.

9. Mortar from Treves four years old.

We see by the above table that none of these mortars contain, by a notable quantity, the portion of carbonic acid required to saturate the lime; since according to the analysis of page 230, vol. xx, lime-stone contains, ordinarily, 33 per cent of carbonic acid. Mortar No. 5, for example, which was nearly two thousand years old, contained only about 13 per cent; and it is to be noticed, as I have already said, that the lime, as we use it in our constructions, is never completely deprived of this acid. We notice also that the hydraulic mortars are those which contain the least carbonate of lime. And lastly that a part of the lime is found united chemically with other substances, such as silex alumine, and iron, and perhaps with all three at the same time. These substances appear to be combined with the lime by calcination.

*Lime produced by different calcined limestones, yielding common lime according to the analysis of Mr. Berthier.*

| | Fat Lime. | | | | | | Meagre Lime. | |
|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| Lime . . | 0.964 | 0.954 | 0.972 | 0.935 | 0.916 | 0.860 | 0.780 | 0.600 |
| Magnesia . | 0.018 | 0.018 | 0.000 | 0.010 | 0.015 | 0.090 | 0.200 | 0.262 |
| Clay . . | 0.018 | 0.028 | 0.028 | 0.040 | 0.069 | 0.050 | 0.020 | 0.000 |
| Oxide of iron &c. | | | | 0.015 | | | | 0.138 |
| | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

1. Limestone of the fresh water formation of Chateau—Landon near Nemours; compact, yellowish, a little cellular, sonorous: yields very fat lime.

2. Limestone of Saint-Jaques; compact, yellow, texture somewhat saccharoidal; it forms the base of the Jura mountains; makes a very greasy lime which hardens but slowly.

3. Lower marine limestone (*calcaire grossier*) of Paris: gives very greasy lime.

4. Limestone which forms the roof of the iron mine of La Voulte (Ardiche;) compact, yellowish white: containing shells which prove it to be contemporaneous with the Jura limestone, specific gravity 2.67: gives very good fat lime.

5. Limestone of Lagneux (Ain:) compact, of a light yellowish gray; affording fat lime which is much used at Lyons.

6. Fresh water limestone of Vichey (Allier:) compact, cellular, yellowish white, gives very good lime, but not very greasy.

7. Limestone of the neighbourhood of Paris, which appears to belong to the fresh water formation: compact, yellowish; gives meagre lime, but not hydraulic.

8. Secondary limestone of Villefranche (Aveyron:) lameller, of an ochery colour, the lime obtained in an experiment on a small scale was very meagre without being hydraulic.

*Limes produced by different limestones, yielding hydraulic lime according to the analysis of Mr. Berthier.*

| | Moderately Hydraulic. | | | | | Very Hydraulic. | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
| Lime . | 0.870 | 0.830 | 0.840 | 0.820 | 0.820 | 0.745 | 0.688 | 0.740 | 0.683 | 0.700 | 0.746 |
| Magnesia | 0.040 | | 0.025 | 0.015 | 0.015 | 0.035 | 0.060 | 0.020 | 0.020 | 0.010 | 0.160 |
| Clay . , | 0.090 | 0.070 | 0.135 | 0.165 | 0.165 | 0.220 | 0.252 | 0.170 | 0.240 | 0.290 | 0.078 |
| Oxide of iron &c. . | | 0.100 | | | | | | 0.070 | 0.057 | | 0.016 |
| | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 | 1.000 |

1. Limestone of Vougny (Loire;) sub lamellar, yellowish, filled with ammonites and other shells; yields very good lime which sets in water.

2. Limestone of Saint-Germain (Ain;) compact, deep gray, veined with white carbonate of lime; lamellar, and penetrated with gryphites, &c., at Lyons this lime is used for hydraulic works.

3. Limestone of Chaunay near Macon; compact, fine grained, yellowish white, it is of the secondary formation: this lime is hydraulic.

4. Limestone of Digne (Jura;) compact, penetrated with plates of calc-spar (*lamelleo de calcaire*) and containing a great number of gryphites, of a deep gray, this lime is hydraulic.

4. Limestone which accompanies the preceding, and which possesses the same properties; compact, of a grain almost earthy; of a clear gray.

6. Secondary limestone of Nimes (Gard;) compact, yellowish gray; affords a hydraulic lime which is there considered of excellent quality.

7. Lezoux lime (Puy-de-Dome;) made of a fresh water calcareous marle; it is said to be excellent, they are in the habit of slaking it by leaving it in heaps in the air, after having moistened it: it produces a copious jelly with acids.

8. Compact limestone of an unknown locality: gives very good hydraulic lime.

9. Secondary limestone of Metz (Moselle;) compact, of a grain almost earthy, of a bluish gray more or less deep: the lime it affords is known to be very hydraulic.

10. Calcareous marle of Senonches, near Dreux (Eure-et-Loir;) compact very tender, may be diffused through water like clay, but does not fall to powder when burnt. This substance is not like the limestones which have an earthy fracture, a mixture of carbonate of lime and clay. It leaves in acids a mealy residue, soft to the touch, which contains only a trace of alumine, which dissolves in liquid caustic potash even when cold, and which comports itself in all respects like silex which has been separated from combination: nevertheless it is certain that this substance exists in the Senonches lime only in the state of mixture: because, by operating with great care, we find by analysis, that the proportion of carbonic acid is exactly that which is necessary to saturate the lime. I have, before, in some varieties of carbonate of magnesia (*magnésie carbonatée*,) encountered silex soluble in alkalis, although not in combination, but have never found it in carbonate of lime. The Senonches lime is very well known: it is much used at Paris: it hardens more promptly, and acquires greater hardness than Metz lime: it dissolves in acids without leaving the least residue. (What Mr. Berthier says here of this lime is very remarkable and deserves to fix attention on this particular kind of lime.)

11. A mixture of four parts of chalk from Meudon and one part of Passy clay (in volume,) which Mr. Saint-Leger uses to make the artificial hydraulic lime of Paris.

If we compare the common limes of the first table, above, with the hydraulic limes of the second, we shall see, 1st. that the latter contains, in general, much more clay than the former: 2d., that several limes contain more than two-tenths of magnesia, without being hydraulic, while they become eminently so, when they contain the same quantity of clay: 3d., that almost all the common limes contain a small portion of clay. We see that No. 5 of the common limes contains, within one thousandth as much clay as No. 2, of limes moderately hydraulic: it is probable that these two limes have about the same degree of hydraulic property, but that it is weak. It would be interesting to know the resistance of the mortars made of all the limes contained in the above two tables. It is only by determining the tenacity of mortars made of limes of which the composition is well known that we can adjust the composition and proportion of clay so as to produce the best hydraulic limes.

## ARTICLE VIII.—*Of Sand, and Hydraulic Sand* (*Arénes.*)

Sands are classed relatively to their constituent parts: thus there are siliceous sands, granitic, calcareous sands, &c., some sands result from the slow decomposition of rocks of the same nature. Sometimes they are mixed; and it often happens that they contain several metallic substances—principally iron.

The different revolutions that the earth has undergone have caused considerable deposits of sand in places where there are now no water courses; and even at great elevations. On certain coasts there are extensive collections of sand, which the French calls *dunes;* these are heaped up by the winds. Rivers transport a great deal of sand, and their shores are some times covered with it. Sands are often mixed with vegetable earth. In this case they are not proper for mortar. To be suitable to this end, they should be almost perfectly free from earthy matter. When on the subject of mortars exposed in the air, I shall point out a very simple means, that I have used for several years, of freeing sands from the earth they contain.

Constructors distinguish sands into *river sand*, *sea sand* and *pit sand.* This last is found in the great deposits mentioned above: it bears the name of *fossil sand,* also: its grain is generally more angular than that of *sea sand* or *river sand.* All these sands contain the same elements. Siliceous, or granitic sand, or a mixture of the two, are most common: calcareous sands are most rare.

Vitruvius, and others after him, thought that *fossil* or *pit* sand was the best for making mortar. Belidor thought, on the contrary, that *river sand* was preferable. Mr. Rondelet has since made experiments which appear to establish that *pit sand* is better than *river sand.*

I purposed examining whether, in fact, there was much difference, in making mortars of one sand rather than of another: but I quitted Strasburg before I could apply myself to the subject. Nevertheless, some facts, of which I shall speak when on the subject of mortars exposed to the air, lead me to believe that the divergence of opinions, as to which are the best sands, results from the experiments having been made with sand more or less fine, or more or less earthy. The experiments cited page 81, show that earth mixed with sand is very injurious to mortars. But the authors quoted above do not say whether, before making these experiments with pit and river sand, they took care to wash both of them. If they did not wash them, the superiority which they found to belong to either, may have been, on one hand, due to the greater freedom from earthy matters of the better sand of the two, and on the other, to the greater fineness of the particles. My results were obtained with granite sand, and it remains to be ascertained whether they would have been the same with other kinds of sand. The question is important, and should be examined with care.

A species of fossil sand has lately been discovered, which is very remarkable: the knowledge of this singular substance is due to Mr. Girard de Caudemberg, Engineer of Roads and Bridges. This Engineer published, in 1827, a very interesting notice of this subject, which cannot fail to produce important results. I will state succinctly the principal facts contained in this notice, and I will add some observations that have been made since.

"There exists" says Mr. Girard," in the valley of the river Isle, fossil sands of which the colour varies from redish brown to yellowish red and even ochre yellow. They are called '*arénes*,* which denomination we shall preserve in this notice, to distinguish them from common sands. These sands are often used alone, as mortar, in walls of enclosures and of houses; and as they have the property of making a paste with water, and as they shrink less than clay, they are very proper for this kind of construction: they represent in this case a *pisé*, which acquires hardness and resists inclemencies. But the proprietors of the mills on the river Isle, in the department Gironde, discovered by accident a quality in the *arenes* much more important and worthy of serious attention; they use it with common lime more or less fat, to form mortars which set under water and acquire great hardness."

Mr. Girard says that for want of hydraulic lime, he made several Locks with mortar composed of common lime and *arenes*. He states that he obtained very good results; and that the following year it was necessary to use the pick to break up the concrete that had been made with these *arenes*.

The examination of the *arenes* showed Mr. Girard that they were all composed of sand and clay in various proportions. By means of washing and decantation he separated the clay from the sand, and in eight kinds of arenes he found the proportions of clay varied from ten to seventy per cent. He ascertained that those arenes which were meagre, were hydraulic only in a very feeble degree. The sand of the arenes is sometimes coarse and sometimes fine: it is occasionally calcareous, but more frequently siliceous or mixed. Some of the arenes are red, others brown, yellow and sometimes white.

The arenes are generally found on the summit of the hillocks which form the basins of rivers and brooks: they are rarely found in valleys. The deposits of the substance are superimposed on masses of argillaceous tufa (*tuf argileux*,) or calcareous rocks; they have all the characters of an alluvial deposit. The beds are often separated by pebbles. Rolled pebbles are, moreover, often seen disseminated here and there in the mass. Some of the beds are more than fifty feet thick. Mr. Girard says it appears to him that the environs of Bordeaux, and the valleys of the Aube and upper Seine, contain a great deal of it; and that it exists in a multitude of localities.

Mr. Girard had occasion to ascertain that the arenes were employed in many ancient constructions, and he cites, among others, the thick revetments of a remnant of fortification at Mucidan (Dordogne) which dates back several centuries, and it appears that the very old constructions at Nimes were made with arenes.

Mr. Girard says he has assured himself by experiments that in preserving for a year under water, mortars containing equal proportions of crude energetic arenes, and the same arenes calcined, that there was no appreciable difference in their consistence; but that the torrefaction of the arenes had the advantage of hastening in a remarkable manner, the setting or induration of the concrete.

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* It appears that the word *arène* was known to several Constructors, for Mr. Sganzin says page 25, in speaking of Sands: "They call *arènes* those of which the particles are finer and more regular." And this is all he says. Au.

Mr. Avril and Payen discovered, about the same time, in Bretagne, the properties of puzzalona, in gray wacke, and in decomposed granite, though to a degree quite feeble. They remarked, besides, that natural puzzalonas acquire a new degree of energy by a slight calcination.

Captain Leblanc of the Engineers, employed at Peronne, gave on the 30th November 1827, an interesting memoir on the arenes which are found in great quantity in the neighbourhood of that place. I will transcribe the commencement of the memoir. "In the numerous demolitions, made in 1825 and more especially in 1826, preparatory to the repair of the crown work of Paris, it was remarked that the ancient mortars (from 150 to 600 years old) were generally very hard. It was particularly noticed, at the time of the demolition of the piers of bridge forty-one, which was situated in quick sand, below the level of the waters, that the mortar was harder than elsewhere. To these facts the only exception was in the demolition of scarp thirty-three at the close of the year 1826. The mortar of this masonry was still soft. On examining the mortars which were hard, it was perceived that the sand therein was very fine, and that these mortars, from their aspect, seemed to have been made of the sand of the country, rejected in the official instructions, because too earthy. (This sand is used in all the constructions of the town.) Another consideration led to the belief that the sand of the country had been used: for all this masonry appeared to be very carelessly put together; the mortar, badly made, showed every where, lumps as large as a hazle nut, of lime not mixed with sand and still soft; although all the surrounding mortar was very hard. It was to be presumed that when applying so little care to all parts of the workmanship, the constructors had taken no greater, as to the choice of sand: and that they used that which was nearest at hand—namely the sand of the country. We have said that the mortar of scarp thirty-three was found still soft after two hundred years: it seemed on examination to be meagre; and, although the sand seemed to be the sand of the country, the mortar did not look like the other; under these circumstances, this example suspended, for the time, the conclusions that had already been drawn as to the advantage of using the Peronne sands."

The author states that on recommencing labours in 1827, he made six cubes of mortar, of which three were composed of sand recommended in official instructions, and the other three of the clayey sand whereof the good masonry appeared to have been made. One cube ot each kind of mortar was left in the air, one put in a humid place, and one in water.

It was in this interval, as Capt. LeBlanc states, that the notice of Mr. Girard appeared. What was said in that notice showed that the clayey sand of the neighbourhood of Peronne was a true arene. The mortar made of common lime and this arene had completely hardened in the water at the expiration of a month; so as to receive no impression when borne upon strongly by the thumb. A mortar made at the same time of the same lime and of the sand recommended officially, and usually employed, remained entirely soft at the end of several months. By heating the arenes, Capt. LeBlanc ascertained that the hardening took place much more promptly, for the mortars made of the crude arenes required a month to harden, whereas those made of arenes that had been heated, hardened in eight or ten days. This officer undertook some experiments to determine the degree of calcination proper to impart the quality of most prompt hardening, and to ascertain whether the effect of calcination would be to augment in a sensible manner, the strength of mortars, but his experiments are not yet finished. The discovery of arenes in the environs of Peronne, is, at all events, a great advantage for the works in progress at that place. Masonry in the air may be executed with crude arenes; and if it appear that calcination augments both the promptitude of hardening and the solidity of mortars, this operation might be resorted to in all cases of constructions in water.

The arenes of the environs of Peronne are found on the tops of the hillocks which border the valley of the Somme, like those of the valley of the Isle, and they lie upon a calcareous mass. Towards the bottom of the river banks, the arenes are mixed with fine sand, and moderately fine sand, and sometimes, with coarse grains. It is only towards the tops of the hillocks that they are found composed entirely of fine sand. The inhabitants call it clay. It is found, also, on hills quite elevated. Capt. LeBlanc states that the arenes which contain only very fine sand are less hydraulic than those which lie a little lower and which contain a mixture of fine and moderately fine sand; that in those places where the ground rises gently from the river, the banks of sand are always mixed with, and sometimes separated by rolled or broken pebbles, which is another point of resemblance with the arenes of the valley of the Isle, as described by Mr. Girard. The colour of these arenes is obscurely reddish, a good deal resembling bistre: they present the appearance of an ochrey earth.

Capt. LeBlanc adds that since the discovery of the arenes of Peronne, they have been found at Bapaume, at Douai, on the road from Bethune to Arras, and that this substance appears to be very common in the valley of the Somme, and in Flanders. At Bapaume, the workmen have known for a long time that this clay was hydraulic: the millers of the neighbourhood having executed works in the water therewith, with very good results. In the month of July last, Captain LeBlanc informed me that there had been found in the neighborhood of Ham, an arene pronounced to be more hydraulic than that of Peronne, and that it was used a long time ago in the fortifications of the castle.

I procured some of the arenes from Ham: they sent me two kinds; one yellow and the other greenish. We shall see in the sequel that they are clays. I satisfied myself that they contained no lime. I made two kinds of mortar therewith, taking one part of lime in paste to two parts of the arenes, and put them under water. I made a similar mortar with puzzalona. The puzzalona mortar hardened completely in six days: the two mortars made of arenes had not fully hardened at the end of three months. These experiments were made last December, which retarded the induration no doubt; but being placed in a chamber where the temperature was about ten degrees, (cen?) (50 Far.,) I was astonished at the slowness of the induration.

I calcined some of the greenish arene, keeping part at a low red heat for half an hour in a crucible; another part during one hour; and a third portion during two hours. I then made three mortars like the above, with these three calcined arenes. The two mortars of the arenes, calcined, one for half an hour, and the other for an hour, hardened in a month. That calcined for two hours, required nearly two months to attain the same degree of hardness. It is true that I did not calcine this substance in a current of air; but I was surprised that, being calcined, it did not harden sooner. It will be important to make many experiments on different arenes, crude, and calcined in various degrees, so as to know the greatest promptitude of induration that can be secured, and the tenacity of mortars both in air and water.

Two specimens of mortar taken from the Castle of Ham were sent to me: one of these mortars was made in 1601, and the other in 1802; they were both of very strong consistence. I found, nevertheless, that they did not offer the same degree of hardness as mortars made of trass and hydraulic cement; but these arenes will be not the less advantageous in constructions in water and in air, on account of the great economy that attends their use. In places where good arenes are at hand, they should, in cases where a prompt hardening is required, in caps of arches, &c., always be employed mixed with hydraulic cement.

I had occasion to notice, a short time since, between the park of Versailles and Saint Cyr, a hillock of clayey sand which looked to me like the sand from Ham: some was yellow and some red; the colours being well separated. I made with these two clayey sands, two mortars composed of one part of fat lime and two parts of these sands, and placed them in water. They were not indurated at the end of four months, but it was perceptible to the touch, that they had taken a degree of consistency.

At Paris they build the walls of houses with plaster, and cellar walls with mortar. I have had occasion to observe latterly, that several of these mortars were made of clayey sand which appeared to me to be a species of arene: it contained a little lime, and some of it is yellow, and some greenish, like that from Ham. I learned that this sand was brought from the neighborhood of the ancient garden of Tivoli, and that it appears to have been employed at Paris for a long time to improve mortars. I made two mortars of these two clayey sands, adopting the same proportions as with the sands from Saint Cyr, and placed them in water. The results were similar to those given by the clayey sands from Saint Cyr. From what has been said, we see that these clayey sands are arenes of little energy: they do not appear to me to be proper for mortars that are to be placed in water; but the hydraulic property they possess, feeble as it is, will give, for works in the air, much better mortar than ordinary sand. From what has been stated above, it appears probable that there exist several banks of arenes in the neighborhood of the Capital; and it is probable some may be found more energetic than those I tried; it will therefore be important to make researches, adopting the same process as is recommended page 31, for cements.

If we mix clay with fat lime, the resulting mortar will take no consistence when put under water. It is necessary that clays be more or less calcined to become hydraulic. Mr. Girard seems to think that the arenes have been submitted to the action of fire, and that perhaps they have a volcanic origin; but this second assertion does not seem to be a necessary consequence of the first; all that we may affirm is, that the arenes are clays which have sustained the action of fire. On the other hand, the small rounded stones and pebbles found in some of these deposits, prove that they are, also, alluvial. It is not easy to meet important facts without seeking to account for them, although at the risk of deceiving ourselves.

The flattening of the poles of the earth, and the swelling out of the equator, demonstrate that our globe has been in a soft state. Some philosophers maintain that the earth was in a state, primitively, of fusion; these are called *Vulcanists.* Others contend that the softness of the earth was an effect of water; these are called *Neptunists.* The opinion of the *Vul-*

*canists* is a very ancient one, and prevailed for a long time; but the great number of shells, the remains of marine animals, and other objects, encountered at very elevated positions, superseded the opinion of the *Vulcanists* with that of the *Neptunists.* Later still, new observations, and amongst others, the great heat of certain thermal waters; the elevated temperature which is found at the bottom of very deep mines; the sudden formation of some islands which have been thrown up from the bottom of the sea, and several other facts, have brought back the old opinion that our globe was primitively in a state of incandescence; and there are, at this day, several philosophers who think that the earth is cooled only at the surface, that it is still in a state of incandescence in the interior, and that volcanoes communicate with this vast focus of heat. But whatever may be the opinion adopted as to the primitive condition of our globe, it cannot be doubted that it has sustained several successive modifications by fire and water. The hypothesis that the globe was at first in a state of incandescence, and that it has since sustained revolutions by the operations of water, is that which appears to me to accord best with various observed facts. The presence of arenes over a considerable extent of France, in places where no traces of extinct volcanoes are to be found, is an important circumstance for geologists. It is curious to see the study of hydraulic mortars furnish new arguments in favor of the theory of the *Vulcanists:* but, as often noticed, all the sciences have some points of contact.

The experiments that I shall give in the second section, on mortars made of fat lime and sand, and exposed to the air, will show how important it is to search after good arenes in the environs of our public works; because it is a means of procuring good mortars at a very cheap rate, and because it is the only means of procuring them cheaply, in countries where there are no hydraulic limes.

(TO BE CONTINUED.)

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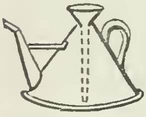
FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

## *Improvement in oil cans, or feeders.* By A. C. Jones, Engineer.



In oiling machinery, especially Locomotive engines, great loss of oil arises from the can being upset or by falling. The improvement, shown in the margin, can be applied to the common can, by soldering a tube to its top which extends internally to within a short distance of the centre of the bottom. A small vent hole is made at the top of the can, to allow the air to escape when filling: it is obvious that the can may be turned bottom upwards, or on its side with a very small loss of oil compared with the old plan.

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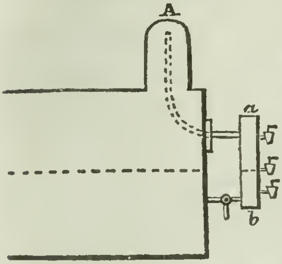
FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

## *Water Gauge for high pressure Steam Boilers.* BY A. C. JONES, Engineer.

The object of this improvement is to find the correct height of the water in a boiler when it *foams.*

The apparatus consists of a tube or chamber *a, b* of the same metal as the boiler about 14 inches long and 2½ inches in the clear. Near the top and bottom a small pipe, or tube, of one-half inch bore is inserted to connect it with the boiler, the top branch being continued by a pipe within the boiler to the highest accessible point; the lower branch is connected below the lowest point at which the water can be worked, and has a cock for the purpose of shutting off the communication with the boiler. Three gauge cocks are inserted in the front of the vertical chamber, *a*, *b*, at the same height as is customary on the old plan of operation. If the cock in the lower branch pipe is left open, the gauge cocks act in the same manner as if in the head of the boiler. If the boiler foams, the lower communication is cut off by the cock, the upper gauge cock is then opened, and if there is any water above it, the pressure of the steam on its surface forces it out to the level of the cock and no farther, and the length of time it takes to discharge the water, with a little practice gives the height of the water line above the cock; if no water is discharged from the upper cock it is shut, and a trial is made of the others, in succession.



The operation may be repeated by opening the communication with the boiler and allowing the water to rise to its level in the chamber.

I have tested this plan since its first invention (about three years since,) on locomotive, stationary, and steam-boat boilers; with decided success.

## Bibliographical Notice.

*The final report of the committee of the Philadelphia Medical Society, on the construction of instruments, and their mode of action, in the radical cure of Hernia, &c.* By Heber Chase, M. D. Philadelphia, J. G. Auner, p. 243.

There are but few articles which are more frequently presented at the Patent Office as new and useful improvements, than Trusses for the cure of Hernia. A large number of these are but pretended improvements, presented by persons ignorant of what has been heretofore done upon this subject, or anxious only to obtain that species of sanction which the seal of the office is supposed to afford. The work, the title of which is given above, affords much information respecting the construction of such trusses as have been previously used, as well as of those which have been made the subject of a Patent by Dr. Chase; and as we have been supplied with the engravings used in the above work, we have deemed the subject suitable to our pages. One thing is certain, there is not any other point appertaining to our Medical or Surgical practice, in which so large a portion of our readers would be personally interested. Dr. Chase has obtained Letters Patent of the United States, for his trusses, under their various modifications, the nature of which are distinctly pointed out in the following review.

Those of our readers who are engaged in the practice of medicine, may recollect, that in consequence of the great importance of the subject, the Philadelphia Medical Society appointed a committee of Surgeons in the year 1834, with unlimited instructions to investigate the subject of hernia, together with the means employed for treating this disease. This laudable step was undertaken no doubt, in consequence of the numerous trusses of ephemeral existence which are yearly palmed upon the ignorant and unsuspecting, by impostors alleging their capability of curing hernia in all its forms:—a degree of pretension carrying with it the proof of its own fallacy. This committee made its preliminary report on the 5th and 12th of December, 1835, and the final report was read before the Society, and adopted on the 29th of April, 1837. The first of these reports was published in the American Journal of the Medical Sciences for February, 1836. The second, in the No. for August, 1837.

The speculative and theoretical views of the predecessors of the patentee, and of many of the profession, tending to show that a cure in hernia depended upon irritation produced by the instrument, and followed by "adhesive inflammation," was believed to be incorrect.

Doctor Chase, we think justly describes hernia, to be in a majority of cases, a dilation or enlargement of the natural aperture of the body, produced by a variety of causes. Proceeding upon this ground, his aim has been to construct his instruments upon Surgical and Anatomical principles; each instrument being adapted to one appropriate form of the disease only.

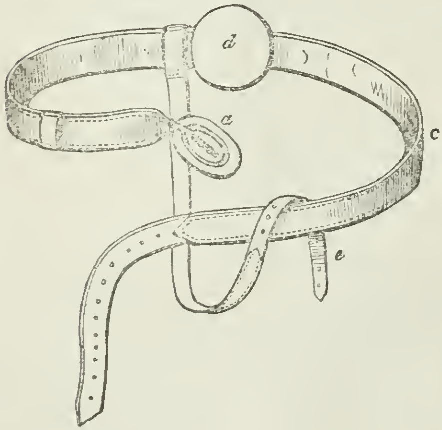
The instruments of Doctor Chase are five in number viz: The Inguinal —Ventro Inguinal—Femoral—Umbilical—and Double Trusses.

The report above referred to, contains 46 pages, 8mo. and is a model for this kind of essay: it is clear, unpretending, and profound, and is evidently the production of a meditative and reflective mind.

We will now give an epitome of the construction of the instruments, mode of application, and method of treatment.

*Dr. Chase's Inguinal Truss, for common or simple Inguinal Herniæ.*

FIG. 1



*a* The block and block-attachment.
*b* The part of the spring which bears the greatest stress and requires the highest temper.
*c* The termination of the spring, made more flexible, and extending to the edge of the os ilium between the two spinous processes on the opposite side of the body.
*d* The back-pad seen in situ.
*e* The perineal strap with its end thrown round the extremity of the spring-cover.

This figure represents the general outline of all the single instruments. Those peculiarities which render them applicable to the different kinds of rupture, remain to be noticed.

The perineal strap *e*, is always found attached to these instruments.

The dorsal pad, *d*, which is novel in its arrangement, consists of a circular disk of metal covered with buckskin. It is attached to the spring by a leathern loop, permitting it to be moved to either side at will. By this arrangement, the back and spine are relieved from that irritation and consequent inflammation which not unfrequently result from the pads of Hull and others, which are immovable, and which sometimes lay the foundation of serious diseases in those parts.

*Chase's common Inguinal Block, with attachment.*

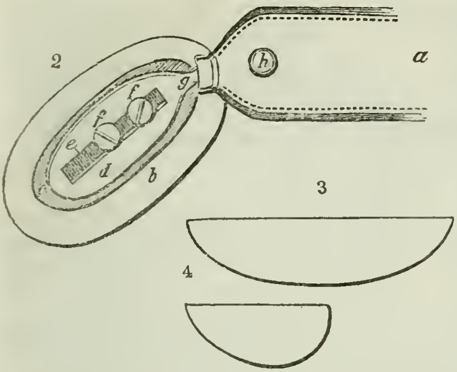


Fig. 2.—*a* The extremity of the main-spring of the truss.

*b* The block.

*c* The brass block-rider: the screws by which it is attached being covered by the block-slide.

*d* The block-slide.

*e* The window in the block-slide.

*f f* The two broad-headed screws of the block-adjustment, securing the rider to the slide, and, when loosened, sliding freely in the window.

*g* The soft iron flexible neck, attaching the block-slide to the main-spring.

*h* The button for the pelvic strap, which is generally used for the perineal strap also.

The proper perineal strap-button on the end of the block-slide is omitted in this and some succeeding figures, to prevent confusion.

Fig. 3—Longitudinal section of the block.

Fig. 4—Transverse section of the same.

The block *b*, of this instrument may be described as consisting of a longitudinal section of an oval spheroid, moulded by a force producing some flatness on one side. When applied, it extends from the pubic bone along the rout of the inguinal canal to a few lines above the internal ring, giving equal pressure and perfect security against the escape of the viscera throughout its whole extent. In this form of hernia we are advised the pressure should be made over the *internal abdominal ring*, extending as a further protection along the rout of the canal.

Having analyzed the several parts of the Inguinal Truss of Dr. Chase, the committee say that they felt bound honestly to state their conviction that this instrument surpasses all others known to them in the accuracy and permanence of its retentive power in common Inguinal Hernia; a conviction fully sustained by all their practical observations of the action of trusses. The instrument is worn with so much comfort, that patients generally relinquish it unwillingly, and have sometimes *absolutely refused so to do* even when pronounced well by the Surgeon.

The committee did not find themselves able to suggest any improvement, or to point out any defect of principle or construction in this truss as now employed by the inventor." See Rep. p. 555, Amer. Jour. Med. Soc.

*Chase's Ventro-Inguinal block, with attachment.*

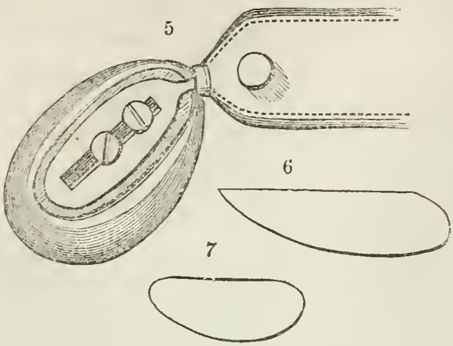


Fig. 5.—The attachment being in all respects similar to that in fig. 10, no references are required.

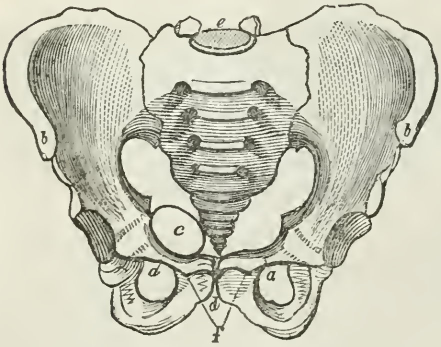
Fig. 6.—Longitudinal section of the block.

Fig. 7.—Transverse section.

The block of this instrument, resembles the common Inguinal truss-block, strongly compressed at its broader convexity, and made to overhang its base, so as to be adapted accurately to that part of the pubic bone over which the bowel passes in Ventro-Inguinal hernia.

In this variety of the disease, the pressure is given *over the external ring* and very near to the pubic bone. The following cut illustrates the position here taken.

*Fig.* 8.—*A view of the pelvis, with Chase' Ventro-Inguinal block in situ—to show the adaptation of its curvature to the form of the body and spine of the os pubis.*



*a a* The bodies of the pubic bones.
*b b* The anterior superior spinous processes of the ilia.
*c* The ventro-inguinal block in situ.
*d* The symphysis pubis.
*e* The base of the sacrum.
*f* The spines of the pubic bones.

The only part peculiar in this truss is the block; all the others are identical with the Inguinal Truss of Dr. Chase.

"The form of Chase's ventro-inguinal block is so accurately adapted to that of the os pubis, that it has secured the bowel perfectly in every instance of ventro-inguinal hernia in which it has been seen applied by the committee."

"To the complete instrument, as it has been actually employed by the inventor during the last year, the committee may safely apply the same language used in concluding their remarks on the Inguinal Truss."

Rep. p. 558. Op. Cit.

*Chase's Femoral block with attachment.*

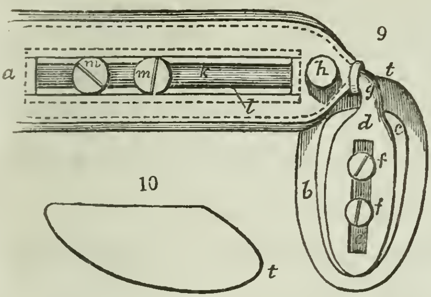


FIG. 9.—The letters from *a* to *h*, inclusive, have the same reference as in fig. 2.

*k* A window in the anterior extremity of the main-spring.

*l* The iron neck of the block-slide continued along the main-spring for some inches and seen through the window *k*.

*m m* Two broad-headed screws of the spring-adjustment, securing the flattened extremity of the iron neck to the main-spring, and, when loose, permitting it to slide on the main-spring.

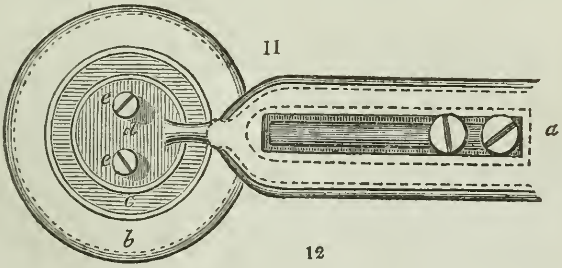
FIG. 10.—A longitudinal section of the femoral block.

The block of this instrument resembles a hen's egg held in a perpendicular position, with its larger end upwards, and flattened on one side, to which the block-rider (*c* fig. 9) is secured. Its pressure is made between the femoral vein and the os pubis, and over the site of the femoral ring; while the upper extremity (*t*) affords its pressure below Poupart's ligament.

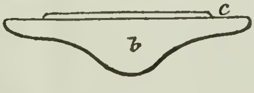
This block has a double adjustment, one at (*f f*) enabling the surgeon to raise or depress the block at will, and a second, regulated by the screws (*m m*) to meet the peculiarities of individual pelves in regard to the distance between the wing of the ilium and the femoral ring. This double adjustment is undoubtedly novel, perfectly secure and accurate.

The spring of this instrument with its appendages, is similar to the instruments before described.

FIG. 11.—*Chase's Umbilical Block and Attachment.*



12



*a* The anterior end of the spring, with the same kind of spring-attachments as in the femoral truss.

*b* The circular block.

*c* The circular block-rider.

*d* The circular iron disk supporting the block-rider.

*e e* Two button-headed screws attaching the rider to the disk, and serving at the same time to secure the strap.

FIG. 12.—Section of the circular block.

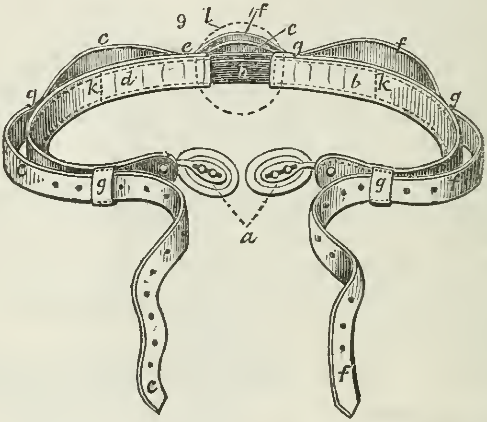
The novelty in this block consists in its central prominence, which may be raised on its convex face to any degree required. This prominence is a segment of a much smaller sphere than the margin of the block *b*. The central prominence is made broader or narrower, is more or less raised according as the case under treatment requires; and in employing the umbilical truss, the inventor is desirous of pressing back the ruptured or dilated parts, to the situation in which nature would have retained them, had union taken place at the umbilicus at birth.

The dorsal-pad of this instrument is oblong, and is attached to the spring by two loops.

Scapularies are sometimes used with this instrument.

*Fig.* 13.—*Chase's Double Truss—prepared for a double Inguinal Hernia.*

FIG. 13.



*a* The two common inguinal blocks with their attachments.

*b* The spring-cover of the left truss terminating in the strap *c c c c*.

*c c c c* The pelvic strap of the left truss, thrown into loops, and passing through an opening beneath the base of the attachment of the strap on the right side at *e*, like the flexor tendons of the last phalanx of the fingers through the terminations of those of the second phalanx.

*d* The spring-cover of the right truss terminating in the strap *f f f f*.

*e* The site of the commencement of the pelvic strap of the right truss, secured by the edges to the spring-cover, but permitting the left pelvic strap to pass up from under its base so as to become superficial in the rest of its course: this arrangement being concealed by the instrument.

*f f f f* The pelvic strap of the right truss thrown into loops.

*g g g g g* Loops confining each pelvic strap respectively to the spring-cover of the opposite truss.

*h* The two springs seen one behind the other, and naked, between the ends of the spring-cover.

*k k* Dotted lines representing the spots where the spring of each truss terminates within the spring-cover of its fellow.

*l* A dotted line representing the proper position for the back-pad.

Of all the various apparatus for the treatment of hernia, not one specimen exhibited so perfect a combination of springs and their appendages, or embraced so complete an assemblage of mechanical advantages applied to the retention of hernia, as this instrument. The chairman of the committee in noticing this instrument, uses the following language. "Since the preliminary report was read, Dr. Chase has invented the admirable instrument now for the first time presented to the society. It is an association of two single trusses, so combined as to be perfectly independent in their action, without the slightest mutual interference, yet so associated by means of the straps and loose spring-covers, that they present the appearance, and act with all the convenience of a single instrument. Each spring, at its posterior extremity, re-enters the spring-cover of its fellow, and the strap of one truss passes smoothly through a passage beneath the commencement of that of the other, so that both sides appear symmetrical, as far as the springs and appendages are concerned, and the straps do not in the slightest degree embarrass each other. As the peculiarities of this instrument are confined to the spring-covers and straps, which are suited alike to the trusses for inguinal, ventro-inguinal, and femoral hernia, the instrument can be adapted at a moment's notice, to any possible combination of these three forms of the disease, so long as the varieties exist on opposite sides of the abdomen.

"The committee cannot speak too highly of this beautiful invention, but it may be safely permitted to speak for itself."

We have now reviewed in a cursory manner the instruments of Dr. Chase, and we only regret that the limits afforded, will not permit us to enter more fully into the subject. The cuts, however, of which we have availed ourselves in this instance, will in a great degree enable the reader to estimate the value of the improvements.

From a review of the whole subject as presented in the report, it may be fairly averred that Dr. Chase has closely studied the anatomy of hernia, that he has manifested great mechanical skill in the construction of his instruments, and that he is intimately acquainted with the action of trusses generally. Whether a set of instruments can be devised better calculated to fulfil all the indications required for the successful treatment of this very troublesome malady, may admit of much doubt; with our present knowledge of the disease, improvement seems scarcely desirable.

The patentee's claims, making a part of the specification of his patent, are as follows:—

"Notwithstanding that I have in the preceding specification set forth by an exact description the instruments as used by me in the cure of the different kinds of hernia, and have given particular admeasurements for springs, blocks or pads, &c.; still I wish to be particularly understood that in all cases of hernia I vary my treatment in relation to the size of instruments, agreeably to the age of the patient and state of the case, governing myself according to existing circumstances, but at all times adhering to the principles set forth in this specification. In my apparatus, and the several instruments of which it is composed, the pads or blocks are adapted to the several varieties of hernia with due and strict attention to the anatomical and physiological peculiarities of the parts interested in the several varieties of the disease, the said pads or blocks being so constructed and attached as to secure the permanent and certain retention of the bowel in all cases which admit of retention by mechanical means, thus allowing the powers of nature, if possible, to close the orifice by which the bowel escapes from the cavity of the abdomen in this disease, which result is not obtained with certainty by any other instruments previously invented.

"I claim the peculiar mode of attachment for the block, as given in the description of each instrument, including the block-slide adjustment of the inguinal and ventro-inguinal trusses, and the block-slide adjustment, and the spring adjustment of the femoral truss, and spring adjustment with the permanent block attachment of the umbilical truss.

"I claim also the new method of employing dorsal pads in all the trusses, by which method the said pads are made movable, so as to slide to any distance which may be required.

"I claim the peculiar double truss herein described, namely, the employment of two springs sliding upon each other with pads or blocks attached and combined in such a manner as to act like one entire instrument, by whatever arrangement of the springs and straps such a result may be obtained.

"Lastly, I claim the several improvements which have been described and specifically claimed independently of the material of which they may be constructed, and whatever alterations in form or size they may hereafter undergo, so that similar effects are produced by analogous means.

"For a further illustration of the peculiarities, and construction, and form, upon which the operation of the foregoing instruments are dependent, I refer to the drawings with written references thereto, deposited by me in the patent office, in compliance with the requirements of the patent law."

The committee thus conclude their remarks upon the instruments of Dr. Chase:—

"After all that has been stated, the committee feel themselves fully warranted in the following conclusions.

"1. The retentive power of solid blocks is, *cæteris paribus*, superior to that of soft pads in the treatment of hernia, as has been already stated in the Preliminary Report.

"2. The chances of radical cure depend upon the perfection and permanence of the retention.

"The perfection and permanence of the retention depend—first, upon the mechanical action of the instruments; and, secondly, upon the power of the parts affected to bear that action without danger of physiological accidents of sufficient importance to interfere with the treatment.

"4. All the instruments with solid blocks contrived before the recent inventions of Dr. Chase, are decidedly liable to important mechanical objections, and all of them, with the exception of the Rachet truss, are moreover capable of producing physiological accidents of sufficient importance to interfere with the treatment.

"5. The construction of the Rachet truss is such as to render retention uncertain, even in ventro-inguinal hernia, to which form of the disease alone, it is tolerably will adapted.

"6. The instruments of Dr. Chase have effected the permanent and accurate retention of the intestines in every case of hernia observed by the committee, without material inconvenience to the patient, and often under trials more severe than are usually ventured upon by those who wear other trusses; trials which would be imprudent with any other apparatus known to the committee.

"7. If we except the femoral truss, these instruments have stood the test of much practical application, without superinducing any physiological accidents of sufficient importance to interfere with the treatment.

"8. The mechanical principles upon which the femoral truss is constructed, appear highly ingenious and promising; and unless this instrument should be found hereafter to be productive of important physiological accidents, it must take precedence of all other modes of treating this variety of the disease. No such accidents are yet known to have been produced by its employment; but the committee have not enjoyed the opportunity of personal inspection in a sufficient number of cases to determine general results, nor do they deem it proper to receive evidence from any other quarter in discharging the trust reposed in them by the society.

"The committee are induced, by the foregoing conclusions, to recommend in strong terms, the instruments of Dr. Chase to the confidence of the profession, as the best known means of mechanical retention in hernia, and as furnishing the highest chances of radical cure."

## Franklin Institute.

### *Annual Meeting.*

The Annual Meeting of the Institute was held at their Hall, on Thursday evening, January 18th, 1838.

James Ronaldson, Esq., President, in the chair.

Solomon Roberts, Esq., Recording Secretary, pro. tem.

The minutes of the last Quarterly Meeting were read and approved.

Donations of books were received from the Zoological Society of London; the Royal Geographical Society of London; Mr. John Gummere, of Haverford, Pa.; Mr. Samuel Colman, of New York; and A. L. Elwyn, M. D., R. Bridges, M. D., Heber Chase, M. D., and Mr. Robert Davis, of Philadelphia.

The Actuary laid on the tables the periodicals received during the past quarter in exchange for the Journal of the Institute.

The Annual report of the Board of Managers was read, and, on motion, was accepted, and referred to the Committee on Publications.

The Treasurer presented his report of the funds for the last quarter, and also a statement for the year ending December 31st, 1837—which were read and accepted.

The Committee on Publications presented their report on the operations of the Journal of the Institute for the year ending December 31st, 1837, which was read and accepted.

Mr. John Horton, from the Committee of Tellers of the election for officers and managers of the Institute tor the ensuing year, (appointed at the preparatory meeting this day,) presented their report of the result of the election, when the President declared the following gentlemen as duly elected:

James Ronaldson, President.
Isaiah Lukens, } Vice Presidents.
Thomas Fletcher, }
Isaac B. Garrigues, Recording Secretary.
Isaac Hays, M. D., Corresponding Secretary.
Frederick Fraley, Treasurer.

*Managers.*

Samuel V. Merrick,
Abraham Miller,
William H. Keating,
John Struthers,
Matthias W. Baldwin,
Alex. Dallas Bache,
Jas. Henry Buckley,
Alexander Ferguson,
John Agnew,
John Wiegand,
Alexander M'Clurg,
Samuel Hufty,
John C. Cresson,
James M. Linnard,
Andrew M. Eastwick,
Isaac P. Morris,
Charles B. Trego,
Henry Troth,
John S. Warner,
William H. Carr,
*Robert M. Patterson,
*Henry D. Rogers,
*John Gilder,
*William D. Parrish.

(Extract from the minutes.)

James Ronaldson, *President.*

Solomon W. Roberts, *Rec. Sec. P. T.*

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## *Fourteenth Annual Report of the Board of Managers of the Franklin Institute.*

On the return of the period which terminates their official career, the Managers of the Franklin Institute present to their fellow members their Fourteenth Annual Report.

It is with sentiments of unalloyed satisfaction, that the managers feel themselves authorized on this occasion, to renew their congratulations upon the continued success which has attended the labours of the Institute, in its useful and unpretending career.

Notwithstanding the temporary cloud, which has cast so deep a shadow over our recent manufacturing prosperity, the Institute has continued to receive the undiminished support of its members; and has, in return, imparted to them its accustomed, varied, gifts of knowledge, by means of its lectures and drawing school, its library and cabinets of minerals and models, by the social and informal interchange of opinion and experience at the Monthly Conversation Meetings, and by the valuable fund of practical and scientific information, spread upon the pages of its Journal.

Nor have its benefits been diffused only within the circle of its own members, widely as that circle is now extended.

The Committee on Science and the Arts, have maintained their zeal and activity, with no other incitement than the love of doing good; and will have contributed no small share of disinterested exertion to the common weal.

| | |
|---|---|
| Number of new subjects brought before the Committee | 37 |
| Do. lying over from last year - - - | 8 |
| | 45 |
| Do. disposed of by report or otherwise - | 41 |
| Do. remaining for future action - - | 4 |

The Committee on Explosions of Steam Boilers, after a laborious investigation, continued during four successive years, have completed the task assigned to them; and their reports to the government of the United States have furnished a fund of valuable materials, which may constitute the basis of patriotic and wise legislation for the protection of the lives and property of our citizens.

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*New members.

The Committee on Weights and Measures, after reporting to the legislature of this state, a projeét of laws for ensuring a uniform system, have been engaged in maturing the plan for carrying the law into effect; and are now prepared to verify the standards of weights and measures, whenever the requisite authority shall be delegated to them by the Executive.

In the early part of last year, the Board decided that it was inexpedient to hold the usual exhibitions of American manufactures, on the return of the biennial period in the autumn of 1837. Although this decision was not founded upon any anticipation of the general paralysis of business, which has since occurred; an additional cause for approval of their course is found in the almost total cessation of manufacturing operations, attending the commercial derangements. As some comment has been made upon the temporary discontinuance of our exhibitions; and the supposition has been entertained, that the omission last year arose from a want of zeal on the part of our members, the Board deem it but just, to lay before the Institute the views on which their decision was founded; leaving it to their successors to determine how far these views shall continue to influence their future course.

At the time when the Franklin Institute first started into existence, the manufactures of Philadelphia, and indeed of the whole Union, were in a condition of weak and destitute infancy. The mechanics of the country were unaided by the enlightening influence of science; and had not yet learned to avail themselves of that great lever of social prosperity, the systematic and free interchange of ideas, and co-operation of interests.

The primary object, therefore, of the Institute at this period, was, to effect an extensive and intimate acquaintance between the various classes of manufacturers, and likewise between the producer and the consumer.

A rapid series of improvements in the arts, partly the cause, and partly the effect, of the exertions of the Institute, called for the frequent repetition of exhibitions, designed to keep the public mind informed of the progress of our domestic industry.

But that state of infantile weakness, and of rapid change, has now in a great measure passed away; and the more mature and steady growth of the arts, does not require, and would not repay the labour of such frequent displays. They were originated with a view to the benefit of the community, and should be continued no longer than the interests of society require. The energies of the institute have become too valuable to be expended in getting up a mere idle pageant.

It is believed, however, that exhibitions of domestic manufactures, of a character worthy the true friends of the arts, might be held at periods of four or five years; which would allow a sufficient lapse of time for the development of important and interesting improvements; and would thus retain their character of novelty and usefulness.

Although any self gratulation on the subject at this time may seem premature, the Board cannot close their report without expressing their sanguine hopes, of the speedy development of a feature of the Institute, which has been warmly cherished in prospect from the earliest days of the society. In their first annual report, the Managers of the Institute suggested the establishment of a school of arts, in which the mechanic, the manufacturer, the miner, and the civil engineer, might receive instruction in all the sciences which have a practical bearing upon their several pursuits; and from that period the Institute has been anxiously looking forward to the time when public opinion should be sufficiently awakened to the vast importance and utility of such an institution.

It is confidently believed that the time has now arrived, in which enlightened legislation, on a subject so deeply interesting to the community at large, and to the mining, manufacturing, and agricultural population of our own state in particular, will be sustained by acclamation, from one extremity of the commonwealth to the other.

There has, probably, never been any public measure pressed upon the attention of our legislature, which has met with more cordial and unanimous approval, from men of all parties and all conditions in society. The conviction being universally entertained, that the claims of the productive classes of the community, upon legislative munificence, are strong and imperative.

The Committee on the Chesnut Street Hall, have effected some further sales of the loan during the year; but have not yet disposed of a sufficient amount to warrant them in carrying into effect the improvements necessary to fit the building for the purposes of the Institute. The property at the present time yields an income beyond the interest on its cost, and there is no reason to doubt that it will continue equally productive until more auspicious times shall enable them to complete the intended alterations, and thus increase the accommodations of the Institute to the extent which its large list of members requires.

During the past year the Institute has elected 188 new members. 93 have been lost by resignation, and 23 by death. Increase during the year 72. Whole number of members 2078.

The following named gentlemen have become life members: Messrs. J. J. Barras, Thos. Earp, Davis Henderson, Jno. K. Kane, Wm. McIlvaine, Israel Morris, Wm. S. Otis, Solomon W. Roberts, Return Sheble, Thos. S. Stewart and Jos. Saxton.

JOHN STRUTHERS, *Chairman.*

WILLIAM HAMILTON, *Actuary.*

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## *Report on Prof. Morse's Electro-Magnetic Telegraph.*

THE COMMITTEE ON SCIENCE AND THE ARTS constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic Arts, to whom was referred for examination, an Electro Magnetic Telegraph invented by Professor F. B. Morse, of the city of New York, REPORT,

That this instrument was exhibited to them in the Hall of the Institute, and every opportunity given by Mr. Morse and his associate Mr. Alfred Vail, to examine it carefully, and to judge of its operation; and they now present the following as the result of their observations.

The instrument may be briefly described as follows:

1st. There is a galvanic battery of sixty pairs of plates, seven by eight and a half inches each, arranged according to the very convenient plan devised by Prof. Hare, and set in action by a solution of sulphate of copper.

2d. The poles of this battery can be connected, at pleasure, with a circuit of copper wire, which, in the experiments we witnessed, was ten miles in length. The greater part of the wire was wound round two cylinders, and the coils insulated from one another, by being covered with cotton thread.

3d. In the middle of this circuit of wire,—that is at what was considered virtually a distance of five miles from the battery, was the *register*. In this there is an electro-magnet, made of a bar of soft iron bent in the form of a horse-shoe, and surrounded by coils of the wire which forms the circuit. The *keeper* of this magnet is at the short arm of a bent lever, at the end of the longer arm of which is a fountain-pen. When the keeper is drawn against the magnet, the pen comes in contact with a roll of paper wound around a cylinder, and makes a mark with ink upon this paper. While the telegraph is in operation, the cylinder which carries the paper, is made to revolve slowly upon its axis, by an apparatus like the kitchen jack, and is at the same time moved forward so that the pen if constantly in contact with the paper would describe a spiral or helix upon its surface.

4th. Near the battery, at one of the stations, there is an interruption in the circuit, the ends of the separated wire entering into two cups, near to each other, containing mercury. Now if a small piece of bent wire be introduced, with an end in each cup, the circuit will be completed, the electro-magnet at the other station will be set in action, the keeper will be drawn against it, and the pen will make a mark upon the revolving paper. On the other hand, when the bent wire is removed from the cups, the circuit will be interrupted, the electro-magnet will instantly cease to act, the keeper will, by its weight, recede a small distance from the magnet, the other end of the lever will rise and lift the pen from the paper, and the marking will cease.

5th. The successive connexions and interruptions of the circuit, are executed by means of an ingenious contrivance for depressing the arch of copper wire into the cups of mercury, and raising it out of them. This apparatus could not be described intelligibly without a figure; but its action was simple, and very satisfactory.

6th. Two systems of signals were exhibited, one representing numbers, the other letters. The numbers consist of nothing more than dots made on the paper, with suitable spaces intervening. Thus ... .. ..... would represent 325, and may either indicate this number itself, or a word in a dictionary, prepared for the purpose, to which this number is attached. The alphabetical signals are made up of combinations of dots and of lines of different lengths.

There are several subsidiary parts of this telegraph which the committee have not thought it necessary to mention particularly. Among these is the use of a second electro-magnet at the register, to give warning by the ringing of a bell, and to set in motion the apparatus for turning the cylinder.

The operation of the telegraph, as exhibited to us, was very satisfactory. The power given to the magnet at the register, through a length of wire of ten miles, was abundantly sufficient for the movements required to mark the signals. The communication of this power was instantaneous. The time required to make the signals was as short, at least, as that necessary in the ordinary telegraphs. It appears to the committee, therefore, that the possibility of using telegraphs upon this plan, in actual practice, is not to be doubted; though difficulties may be anticipated which could not be tested by the trials made with the model.

One of these relates to the insulation and protection of the wires, which are to pass over many miles of distance, to form the circuits between the stations. Mr. Morse has proposed several plans,—the last being to cover the wires with cotton thread, then varnish them thickly with gum-elastic, and enclose the whole in leaden tubes. More practical and economical means will probably be devised; but the fact is not to be concealed that any effectual plan must be very expensive.

Doubts have been raised as to the distance to which the electricity of an ordinary battery can be made efficient; but the committee think that no serious difficulty is to be anticipated as to this point. The experiment with the wire wound in a coil may not, indeed, be deemed conclusive; but one of the members of the committee assisted in an experiment in which a magnet was very sensibly effected by a battery of a single pair through an insulated wire of 2¾ miles in length, of which the folds were four inches apart; and when a battery of ten pairs was used, water was freely decomposed. An experiment is said to have been made with success, on the Birmingham and Manchester rail-road, through a circuit of thirty miles in length.

It may be proper to state that the idea of using electro-magnetism for telegraphic purposes has presented itself to several different individuals, and that it may be difficult to settle among them the question of originality.

The celebrated Gauss has a telegraph of this kind in actual operation, for communicating signals between the University at Gottingen and his magnetic observatory in its vicinity. Mr. Wheatstone of London, has been for some time also engaged in experiments on an electro-magnetic telegraph. But the plan of Professor Morse is, so far as the committee are informed, entirely different from any of those devised by other individuals, all of which act by giving different *directions* to magnetic needles, and would therefore require several circuits of wires between all the stations.

In conclusion the committee beg to state their high gratification with the exhibition of Prof. Morse's telegraph, and their hope that means may be given to him to subject it to the test of an actual experiment made between stations at a considerable distance from each other. The advantages which this telegraph would present, if successful, over every kind heretofore used, make it worthy of the patronage of the government. These are, that the stations may be at a distance asunder far exceeding that to which all other telegraphs are limited,—and that the signals may be given at night and in rains, snow, and fogs, when other telegraphs fail.

(By order of the Committee.) WILLIAM HAMILTON, *Actuary.*
Philadelphia, February 8th, 1838.

## Mechanics' Register.

### LIST OF AMERICAN PATENTS WHICH ISSUED IN MAY 1837.

*With Remarks and Exemplifications by the Editor.*

82. For *a Turning Table for rail-roads*; Jeremiah Myers, Attleborough, Bristol county, Massachusetts, May 8.

There is to be a revolving platform constructed much in the usual way, but it is to be placed upon a carriage with rollers running upon a rail over the pit prepared for the turnabout, which pit may be two or three times as long as it is wide, or as the diameter of the turnabout, which may be drawn along it by means of a chain and windlass. The ends of the pit are circular, and the turning table is to be moved round by a pinion taking into teeth on its lower side.

"The invention claimed consists in placing the revolving circular platform, or turning table, upon a carriage moving upon rails; in making an oblong pit by which the locomotive engines or cars may be run off the turning table at right angles from any part of the pit; and from either end obliquely as well as at right angles, or otherwise, to any part of the work-shop, depot, carriage-house, or other place; and in the facility afforded from the above described form of the pit, of clearing the turning table from snow, ice, or other obstructions: likewise in placing the locomotive engine on a car upon a carriage running at right angles with the track, by which means the locomotive or car may be run off upon any other track parallel with the same. A revolving circular platform, or turning table, is not claimed, but only the method of turning it by the use or application of a circular rack and pinion turned by a crank."

Possibly such a contrivance as the foregoing may be found useful in a workshop, or depot, but it is not likely that it will be applied elsewhere. The latter claim to the circular rack and pinion would scarcely be sustainable; and some of the former claims are to results instead of to the means by which they are produced.

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83. For an *Iron Chest, or Safe*, for the preservation of Books; Benjamin Sherwood, city of New York, May 8.

This chest, safe or bookcase, is to be made in the form of a vertical cylinder. Its security is to result from there being two double cases each filled with a bad conductor of heat. The outer case is a double cylinder, with double heads, a space of about two inches between the two being filled with a mixture of prepared Plaster-of-Paris, and pulverized charcoal. The inner case is similarly made, there being a space of about an inch between it and the outer; it revolves on central gudgeons, has its proper door, which when closed is to be turned round so as to be on the side opposite to that of the outer case.

The claim is to "the principle of suspending by pivots, one safe within another, that the door of the inner one may be shut, and it turned round and secured so as to place the door of the inner and outer safes in different directions from each other; that if by a fall of any great weight upon it the outer door should be thrown open, the inner one being turned round would prevent any exposure of the contents: second, the application of pulverized charcoal and boiled gypsum combined, in fire proof chests, as a non-conductor of heat.

Double chests failed in the intense heat of the fire in New York, and there does not appear to be any thing special in that presented to us above, to protect it under similar circumstances; the mixture of charcoal and gypsum will do no more good than charcoal alone, or various other bad conductors of heat, or, in fact, than a mere air chamber.

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84. For a machine for *Facing and Dressing Stone;* David Hull and John Critcherson, Portland, Cumberland county, Maine, May 8.

The cutting is to be effected by chisels, or cutters, projecting out from a quadrant of a cylinder, which is to be vibrated backward and forward above the stone, being caused to do so by the action of a crank shaft, and fly wheel. The cutters are to be forked, so as to have two edges, and it is said that they will sharpen themselves by their vibratory motion. Perhaps they may, but to us the motion seems well calculated to produce a contrary effect. The claim is to "the double edged cutters placed upon a segment of a cylinder, having a pendulous motion, for cutting and dressing stone, substantially as set forth in the specification."

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85. For a machine for *Cutting and Dressing Granite, Marble, or other Stone*; John D. Buzzell, Cape Elizabeth, Cumberland county, Maine; first patented June 2d, 1836, re-issued on an amended specification, May 15.

The description of this machine is of great length, referring throughout to accompanying drawings. The claims made are to "the particular arrangement and combination of the cutting and polishing cylinders; the chisels or cutters used for cutting, grooving, beading; the method of raising and regulating the material to be operated upon, and the arrangement of the machinery for revolving and moving the cylinders, and moving the carriage."

The chisels for cutting, adapted in shape to the particular purpose for which they are to be used, are fixed in sockets set in spiral rows round a hollow cast iron cylinder, and these, it is said, are to "strike upon the stone in such a manner as to cut the stone and dress and polish it fit for building." The peculiar form of the chisel is described, and is such that it may be shifted in its socket as it wears, and so secured as to present a new cutting edge. There are to be cylinders of stone for grinding and polishing after the cutting; and a wooden cylinder covered with leather, to be used with emery, &c., for the same purpose. How far some of the things claimed may be sustainable, we are not prepared to say; we allude to such as the method of raising and regulating the material. We have not seen this machine in operation, but from those who have we have received very favourable reports. We look for one to be brought to Washington, to be tried on stone for the public buildings.

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86. For improvements in the *Air Pump for Low Pressure Steam Engines;* Thomas B. Silliman, city of New York, May 15. (See specification.)

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87. For an improved mode of *Running Saw Mill Gates upon Irons;* Henry Johnson and Nelson Johnson, Erwin, Steuben county, New York, May 15.

This patent is taken for a trifling alteration in the mode of constructing slides, or guides, of metal, for a saw gate; the claim made is to what is denominated a "spring wedge, for pressing up the box against the slide." This particular contrivance it is not considered worth while to describe, as the making a good slide is a thing of no difficulty whatever.

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88. For a machine for *Cutting, Grinding, and Polishing Granite, Marble, and other kinds of Stone;* Mighill Nutting, Portland, Cumberland county, Maine, May 15.

The patentee says, "I claim as my invention, the hemispherical nuts, as arranged, for raising, and regulating the height of the stone to be cut, ground, or polished. I also claim the particular manner in which I have arranged the springs above the hammers, and those which sustain the chisels upon shafts, by means of which they can be simultaneously raised and lowered. I also claim the manner in which I have arranged and combined the respective parts of the cutter frame, so that the position of the chisels, and of the other parts connected therewith, may be regulated by the turning of the cutter frame upon its axis; and the manner of vibrating this frame by a lateral motion communicated to the said axis."

The hemispherical nuts are set into concave beds, on which they have free motion, so that the screws which are used to regulate the height of the stone, may always turn without binding. The cutters are raised by means of lifters on a revolving shaft, and are so fixed as that the feed of the whole of them may be regulated simultaneously. The chisels are raised to a given height, by means of springs, which are also capable of simultaneous regulation.

The subject of stone cutting machines has arrested the attention of several different inventors within a short period of time, most probably in consequence of the very favorable reports of the success of the machine invented and patented by Mr. Hunter, of Scotland.

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89. For a *Machine for Cutting Grass and Grain;* Alexander M. Wilson, Rhinebeck, Dutchess county, New York.

This is a renewed patent, issued in consequence of the destruction of the original by fire, at the time the patent office was burnt. This patent was noticed at p. 48, vol. xviii. There appears to be some discrepancy between the claims made in the original patent, as there stated, and those in the renewed instrument. The following are the words of the claim as now presented. "What I claim as my invention in the foregoing machine, is the construction of what I call the gathering wheel, with its offsets, made in the way described, and having knives or cutters attached to its lower side; the whole formed and operating substantially in the manner herein set forth."

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90. For improvements in the *Machine for cutting Grass and Grain;* Alexander M. Wilson, Rhinebeck, Dutchess county New York, May 15.

The claim under this patent for an improvement on that last noticed, embraces a sliding gear above the gathering wheel, in combination with a hinge guard plate under the front edge of the wheel, and the clutch box upon the shaft, to allow of the adaptation of the knives and gathering wheel to uneven ground; and also to the manner of balancing the machine.

A machine very similar to this, in appearance, is shown in Loudon's Encyclopedia of Agriculture, p. 422, third edition. The gathering wheel and knives, however, are circular, instead of having breaks, as in Mr. Wilson's. We believe that the difficulties which presented themselves in the Scotch machine have not been removed; there appears to be too much complexity in the instrument itself, and a considerable waste of power in moving the gathering wheel and its load, where the crop is heavy.

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91. For *Boats for Canals, Bays, &c.;* Abraham Morrison, Johnstown, Cambria county, Pennsylvania, May 15. (See specification.)

92. For a new and improved *Mode of Propelling Boats;* Jesse Ong, North Huntingdon, Westmoreland county, Pennsylvania, May 23.

The claim is to "the application of two paddle wheels for the purpose of propelling boats, at the centre of the stern, and having that centre as the common focus of their motions, which are contrary in direction, and their planes at right angles instead of parallel with the direction of the boat, and the direction and order of their strike is such that the created currents, whilst they assist the efficacy of the wheel, are themselves dissipated and destroyed by their successive action on each other."

The paddles are set obliquely to the hub, or centre, of the propelling wheels, which are parallel to, and in the vicinity of, each other. The shaft of one wheel is hollow, to allow that of the other to pass through it, as they are to be propelled in reverse directions, the obliquity of the paddles being reversed.

Attempts have been made to propel boats by means of wheels like the foregoing, but, we believe, on separate axes. How far the reversed force acting upon the water will still the agitation, we are not prepared to say; this must be determined by experience; we, however, do not believe that it will be such as to have much effect in preventing the washing of the banks of canals; the only situation where such an affair is of importance.

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93. For a *Steam Regulator to prevent Explosions in Boilers;* Augustus Eitelgeorge, Cincinnati, Hamilton county, Ohio, May 23.

A boiler is to be made in any of the usual forms, and a second vessel is to be made of the same form, but less in its dimensions, so that when placed within the first there shall be a space of four or five inches between them; the inner vessel, which is called a steam regulator, is to be perforated with numerous holes over its whole surface.

The claim is to "the application to common steam boilers of a perforated steam regulator, of a figure correspondent to that of the boiler in which it is placed, but of smaller dimensions, leaving a space between it and the sides and ends of the boiler, secured by rods or arms extending from the sides and ends of the regulator to the sides and ends of the boiler; the flues passing through both regulator and boiler, for preventing the bursting of the latter, by checking, breaking, or equally distributing, the power of the steam, and thus preventing its acting with too great a force on any part of the boiler."

So far as we remember, this mode of preventing explosions has not been hitherto essayed, and so far as we are able to judge upon such a subject, it never will be essayed by any one who understands any thing of the nature of steam, and who is acquainted with the vast power which has been manifested in most of the explosions which have occurred. We really think that a patent might have been fairly refused on account of the trifling nature of the contrivance; but this ground, when taken, is one of the most offensive to those who imagine that they have made great discoveries. If the thing claimed can be pointed to as having been previously done, this is considered as a mere misfortune; but to call any contrivance worthless which some one has thought worthy of a patent, is an act of the most monstrous injustice, and can arise only from ignorance or interest, or from a combination of the two.

94. For an improvement in the *Construction of Water Wheels;* Nehemiah P. Stanton, Syracuse, Onondagua county, New York, May 23.

Some variations in the mode of constructing this wheel are described, but, in general, it is to be made by forming spiral wings, or floats, on the two ends of a horizontal shaft, and covering these with a tight drum or case. The outer ends of the drums, are enclosed, there being perforations on their peripheries close to the heads, through which the water is to escape from the spirals. The shaft which connects these two wheels passes through an opening at the lower end of a trunk, or floom, against the sides of which the open ends of the drums fit and revolve, and through which they receive their water. The invention claimed, "is the conducting of the diagonal or spiral tapering buckets, with the discharge of the water in the extreme surface of the wheel, or at the point of greatest length of lever."

This contrivance adds another to the catalogue of what are called reaction water wheels. It has some claim to novelty in its form, but it would not be an easy task to tell in what way this variation of form will render it a substantial improvement.

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95. For an improved *Rail for Railways;* John Ruggles, Thomaston, Lincoln county, Maine, May 23. (See specification.)

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96. For an improvement in *Fire Arms and Ordnance;* Henry C. Fay, Lancaster, Worcester county, Massachusetts, May 23.

In this instrument the barrel is connected to the stock by pivots, or trunnions, forming a hinge joint; and when the piece is to be loaded, a spring catch which holds them in place is pressed down, and the barrel depressed, so as to expose the open end of the breech, into which a ready charged metallic tube, or cartouche, is to be inserted, having on its back end a percussion cap.

By the act of loading, above described, the trigger is to be thrown out, and other movements made, preparatory to the discharge of the piece. The claims are of greater length than we think it necessary to transcribe, as they refer to certain peculiarities of structure upon which the patentee must depend for the maintenance of his right, which, however, is not, we think, very likely to be controverted, if controversy is at all dependant upon the actual use of the invention.

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97. For a new mode of *Applying Water to Tub Wheels;* David B. Napier, Liberty, Casey county, Kentucky, May 23.

The claim made is to "the application of water to tub mill wheels by two shoots, through a block or blocks, graduated so as to keep the column of water solid, and acting upon the wheel by pressure; also the band to prevent the escape of water." The two shoots deliver the water at opposite points, and each is to extend one third of the way round the wheel. Particular calculations are furnished for the exact proportions of the various parts, but still there is a want of clearness in the description, which the drawing does not entirely remove.

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98. For an improvement in *Stoves;* Ethan A. Andrews, Boston, Massachusetts, May 30.

We are told that the "invention consists in a part called the *radiator,* which is placed behind the stove, and which may be attached to all kinds of stoves, whether close or open, whatever be the fuel used in them, provided the smoke and gases are carried from them by pipes."

The radiator is formed by two plates of metal an inch or more apart, enclosed at the edges, and it is placed at the back of the stove. Its appearance being something like that of a chimney board, but is to stand out from the fire place, or wall, so that both its sides may be exposed. A pipe leads into it from the back of the stove, and may, when desired, pass directly thence into a chimney, but by closing a valve the draught is made, by means of partitions, to circulate up and down between the two plates of the radiator, whence it escapes through two other pipes into the chimney. The radiator is in effect, therefore, a flattened pipe, or flue, for the distribution of heat. The claim is to "the combination of the stove radiator with its partitions and flues, constructed in the manner and for the purposes described."

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99. For a machine for *Drying Oil Cloths, Painted Floor Cloths, &c.;* Daniel Sampson, Winthrop, Kennebec county, Maine, May 30. (See specification.)

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100. For an *Apparatus to be used in Pointing Cannon;* John Hobday, Portsmouth, Norfolk county, Virginia, May 30.

The general construction of this apparatus is made known with sufficient clearness in the claim, as follows:

"What I claim as my invention, and wish to secure by letters patent, is the constructing of an instrument for the pointing of cannon, which instrument has an index pointing horizontally, or indicating the horizontal position and inclination of the gun to which it is attached; the position of the index being preserved by the action of a pendulous weight to which it is attached."

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101. For an improvement in the art of manufacturing *Cast Iron Cannon;* Cyrus Alger, Boston, Massachusetts, May 30. The specification of this patent will be published in an early number of this Journal.

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102. For a new mode of *Manufacturing Saddle Trees;* William Kelly, White Deer township, Union county, Pennsylvania, May 30. (See specification.)

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103. For a machine for *Hulling and Scouring Rice;* Charles K. Harvey and Erastus Tracy, Poughkeepsie, Dutchess county, New York, May 30.

This machine is constructed something like a grist mill, but instead of stones, a bed and runner of peculiar construction are employed; the lower disk forms the runner, the upper an inverted bed. The inverted bed which has a rim an inch and a half deep, is to be stuffed with curled hair, and over this is to be a covering of strong canvass, with No. 3 emery glued upon it. This is used for hulling; but when the hulled rice is to be scoured, a bed covered with lamb's skin felt, sheared so as to leave the wool three fourths of an inch long, is to be substituted.

The runner is to be constructed like the inverted bed, being, for hulling, covered with No. 3, emery, but for scouring, with emery No. 0.

The claims are to, "*First,* The particular manner of constructing the elastic bed and runner, by the use of curled hair. *Second,* The construction of the inverted bed. *Third,* The particular manner of introducing the grain between the working fans by the convex form of the runner, as shown in the drawing. *Fourth,* The particular arrangement and combination of the different parts, many of which are old, but taken together, present a new arrangement of a machine."

104. For an improved *Cooking and Heating Stove;* Washington Auld, and James Cox, City of Philadelphia, May 30.

The claims refer to parts described in a specification of considerable length, without which, and the drawings, they would not be understood. The apparatus appears to be skillfully arranged, and we would willingly make it fully known; should the patentees hereafter furnish the necessary cuts, we will insert the specification. This we are ready to do whenever so furnished with the means.

105. For an improvement in the *Spiral Bucket Water Wheel;* Joseph C. Green, Fayette, Kennebec county, Maine, May 30.

This water wheel consists of a cylinder grooved from end to end, like a many threaded screw, which cylinder is to be enclosed in a hollow case, or tube, which fits it as closely as may be, but within which it is to revolve; one end of the case is to have a close fitting head, and at the other, where the water is to be discharged, the head may be removed to a greater or less distance by appropriate means, and is called a ventilator. The water is, in general, to be admitted through an opening in the middle of the case, and under pressure of the head. The claims are to "The giving of the grooves or vanes of the wheel a greater obliquity at the discharging than at the receiving point. The use of a head to the cylinder to confine the pressure of the water; and the use of a ventilator regulating the discharge of the water."

We are really at a loss, after reading the specification, and examining the drawing with some care, to perceive in what the merits of the apparatus consist. We find something of novelty, but must wait to learn the amount of utility, and really apprehend that this will prove a minus quantity.

106. For a machine for *Cleaning, Winnowing, and Separating Grain;* Markwell Thomas, Alfred, York county, Maine, May 30.

The claim in this machine is to "the employment of iron circular plates, which are bound in place by iron rods, by which the cylinders are made strong. The leaving a space between the upper and lower ends of said cylinders, and inserting in the shoulders of the inner cylinder, the iron sweeps as shown in the drawing, by which the grain is prevented from entering the joints, and the machine kept free. The employment of a spiral plate, and the mode of arranging the same by which its upper surface is left smooth and uninterrupted by fastenings. The adding a middle sieve by which the withered, defective, or imperfect grain is separated from the full and perfect grain. The double spout with doors by which the smaller or larger grain, the perfect or imperfect of any one kind of grain, may be let into, or kept out of, the cylinder at pleasure.

It will be apparent from the foregoing, that the drawings are essential to the understanding of the particular structure of this machine.

107. For an improvement in the mode of manufacturing *Splints for Friction Matches;* Stephen Dale, Concord, New Hampshire, May 30.

The object of this invention is security from combustion by accidental friction of the matches against each other. Dry pine, or other suitable wood, is to be cut into blocks of proper length, and one end of each block is to be grooved both ways, by saws, so as to divide it into squares of a proper size for a match. Upon the other end a piece of cloth is to be glued, and by means of a knife, or other instrument, passed into the respective grooves, the block is to be split into matches, which will be still held together by the cloth, whilst the grooved ends, upon which the composition is put, will not be in contact with each other. The claim is to this mode of manufacturing splints.

108. For improvements in the mode of constructing *Locks for the Doors of Buildings, &c.*, and in the night latches occasionally attached to the locks of outer doors; James McClory, City of New York, May 30.

This lock is of the kind in which there is a number of tumblers capable of being changed in their arrangement, the bit of the key also consisting of separate pieces, capable of a like permutation; this being a well known device, makes no part of the claim. The tumblers are arranged in a movable box, which can be readily taken out, without otherwise disturbing the lock, when it is desired to change their arrangement; the construction and arrangement of this, forms one of the claims. There is likewise a claim to "the manner of making the key in two parts for the purpose of placing the movable bits thereon, from the upper end of the lower section." This lower section, containing the bits, has a pin which fits into the barrelled part of the upper section, where it is fastened by a wedge. One of the knobs is attached to the spindle by a nut, in a way which appears to be new, and is claimed. These, however, and a movable racking in the night latch, can not be readily understood from description.

109. For improvements in *Many Chambered Cylinder Fire Arms;* Otis W. Whittier, Enfield, Grafton county, New Hampshire, May 30.

This many chambered gun is to have the cylinder of chambers turned by a peculiar arrangement of the parts intended for that purpose. These contrivances have become so numerous, and most of them have proved, or are in a fair way of proving, so altogether valueless, that we deem it unnecessary to attempt a description of them, unless we meet with something which takes them out of the list of mere varieties, and gives to them a specific character.

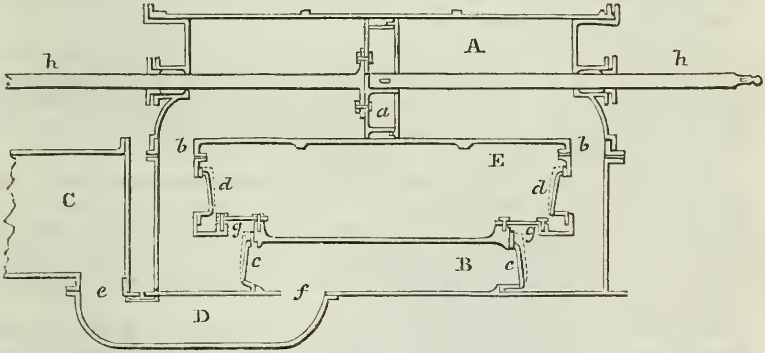
110. For improvements in *Apparatus for Drawing Liquids by Condensed Air;* Jasper Johnson, Genessee, Livingston county, New York, May 30.

This apparatus consists of a cock, and a tube which leads from said cock, down into a cellar or other place where the barrel, or vessel, containing the liquor, is deposited. Connected with this is a cylinder and piston, so arranged and combined with the cock and tube, that air may be forced down the latter by its means, until sufficiently condensed to cause the liquor to rise by the elastic force of the air. The peculiarity consists in an oblique aperture in the cock, which comes into play when the apparatus is employed for condensing, and the claim is to this part alone.

## Specifications of American Patents.

*Specification of a Patent for an improvement in the air pump of low pressure Steam Engines; granted to* Thomas B. Silliman, *city of New York, May* 15*th*, 1837.

The nature of my invention consists in arranging a double acting horizontal air pump with its channels, passages, reservoir, and water pipes, in such a manner as to be applicable to steam boat engines, particularly those constructed upon the horizontal plan; the objects of which are to produce a more uniform effect, to lessen the concussion usually experienced in steam boats from their operation, and obtain such compactness or convenience as may arise from such arrangements.



The accompanying figure represents a longitudinal section of the apparatus; A, is the air pump; B the cylinder; C, a part of the condenser; D, channel plate, connecting the bed plate and condenser; E, reservoir; the water pipe is not seen in the section: *a* is the piston of the air pump; *b*, *b*, nozzles or openings of the same; *c*, *c*, foot valves; *d*, *d*, delivering valves; *e*, opening or nozzle of condenser; *f*, opening between channel plate D, and bed plate B; *g*, *g*, bonnets of foot valves; *h*, *h*, piston rods.

The air pump is operated by means of an upright lever, or beam, and proper connecting rods attached to the crosshead of the engine.

When in operation the water and air contained in the condenser, passes through the channel plate D, from *e* to *f*, into the bed plate B, between the two foot valves *c*, *c*, from thence through either foot valve alternately into cylinder A, through the nozzles *b*, *b;* thence the water, by occupying the lowest place in the cylinder, returns first and passes into the reservoir E, through the opening of the delivery valves *d*, *d*, followed by the air and vapour which, by occupying the upper part of the cylinder, presses upon the surface of the water with an elastic force, which in addition to the gravity of the water, produces an easy delivery of the water into the reservoir, and avoiding the blow which the piston usually produces upon the water in the common arrangement.

What I claim as my invention and desire to secure by Letters Patent is, *First*, the arrangement of the channel way contained in the channel plate for the purpose of admitting the water into the bed plate between the foot valves. *Secondly*, the arrangement of the reservoir so as to receive the water from the two delivery valves attached to the opposite ends of the pump, and conduct it to the water pipe, through which it passes from the boat. *Thirdly*, the arrangement of the delivery valves and nozzles below the cylinder of the air pump, in such manner that the elasticity of the air, and gravity of the water may both conduce to the easy operation of the pump. *Fourthly*, the arrangement of the air pump of steam boats, horizontally, and in manner to allow its working a double stroke, with its combinations substantially as above described.

T. B. Silliman.

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## *Specification of a Patent for improvements in the construction of Canal Boats; granted to* Abraham Morrison, *of Johnstown, in the county of Cambria, and State of Pennsylvania, May 15th,* 1837.

To all whom it may concern: Be it known, that I, Abraham Morrison, of Johnstown, in the county of Cambria, and State of Pennsylvania, have invented a new and improved mode of constructing boats for canals, bays, lakes, and navigable rivers; and I do hereby declare that the following is a full and exact description of the same.

In giving my description I shall assume certain admeasurements, and proportion of parts, and although I shall, in so doing, give such as I believe to be well calculated to answer the purpose intended, I do not intend to limit myself in these particulars, as much latitude may be allowed in these respects whilst the principle upon which my improvements is dependent is still retained.

The form of the bottom of my boat is the reverse of that usually adopted, as, instead of being convex in the cross section, I make it concave in the cross section, from stem to stern. In building a boat of sixty feet in length, I take plank twelve feet long, thirteen inches broad, and one and a half inch thick, and these I cut to a curve of nine inches in their whole length, so that in the middle they will be only four inches wide. Of these there may be twenty-one pieces, which are to constitute the cross plank upon which the bottom and floor of my boat are to be fastened; the average distance apart of these cross pieces, when placed on edge, will be three feet. In building my boat, I first place these on edge, with the hollow side upwards, having first the side standards rabitted into, and riveted fast to the ends of the cross plank, to which the side plank are to be spiked, and so as to range properly, and then spike on the bottom sheeting of inch and a quarter plank. In arranging the cross plank and side standards, they are placed on a line for three fourths of the length of the boat, and thence, towards the bow, they are to have such an inclination as will elevate it about twelve inches. The side plank is put on upon the ends of the cross plank, and spiked, or nailed, or screwed, to the side standards, so as to be about two inches below their lower corners, and they will consequently, project about an inch below the bottom sheeting; they are also to rise two inches above the floor, which will require plank of eighteen inches in width.

The cross plank being thus secured together, whilst this part of the boat is bottom upwards, it is then turned over, and the superstructure completed, a floor of strong inch plank is to be laid upon the cross pieces, and the side standards are to be raised, which may extend to the height of six feet above the floor, in a vertical line. The sides, top, stem, stern, and bows, may be finished in any way which may be preferred.

To give additional strength to this boat, I take two iron rods, each thirty feet in length, and three-fourths of an inch in diameter, and extend them from side to side of the boat, so as to cross each other at or near the centre, securing their ends firmly to the side plank, just below the floor. I also bolt the two sides together by means of six bars of iron, of the same size, crossing the boat about two inches below the floor.

Having thus fully described the manner in which I construct my canal boats, I hereby declare that I rest my claim to invention solely upon the form which I give to the bottom of the boat, which is concave from stem to stern, and straight, with the exception of the elevation towards the bows, as hereinbefore fully set forth.

ABRAHAM MORRISON.

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*Specification of a Patent for an improved Rail for Railways; granted to* JOHN RUGGLES, *Thomaston, Lincoln county, Maine, May 23d,* 1837.

FIG. 1.

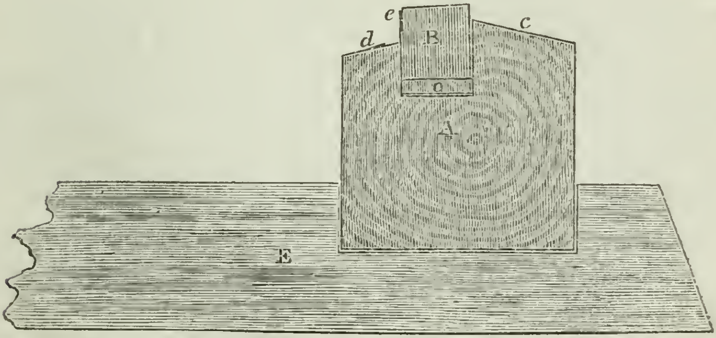
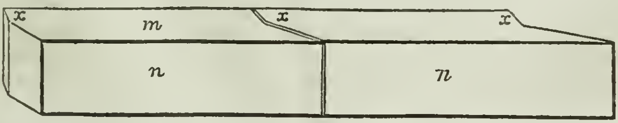


FIG. 2.



Be it known that I, John Ruggles, of Thomaston, county of Lincoln, State of Maine, have invented a new and improved rail for railways, calculated greatly to diminish the expense of railways, increase the adhesion of the driving wheels of the locomotive engine, while it combines firmness and durability.

The following is a just description thereof; that is to say, string-pieces are laid on cross-ties, or sleepers, in the manner usual for supporting a flat-iron rail. The string-pieces may be eight inches in width by nine or ten inches in depth. Along the upper sides of the string-pieces, a tranverse section of which is seen at A, fig. 1, in the annexed drawing, is a groove three inches wide, being three inches and a half from the outside, and one inch and a half from the inside, for the insertion of a block rail B, fig. 1. The string-piece is bevilled at *c* and *d*, that water may not stand upon it; and the rail, which is three inches wide by four inches in depth, extends one inch above the string-piece on the outside, while the inside of the string-piece is reduced two inches below the top of the rail to make room for the flanches of the wheels. The block-rail is made of hard wood plank, by sawing the plank transversely to the grain of the wood, into blocks four inches in length, measuring with the grain, which being inserted into the groove side by side form a continuous rail with the grain of the wood perpendicular. The ends of the blocks where they unite in the rail should present, one of them, a convex obtuse angle, and the other a concave to correspond with it from top to bottom, to unite them more firmly, as shown at *x*, *x*, *x*, fig. 2. The blocks should be dowelled with three fourths inch dowels, and pressed firmly together by wedging or otherwise. If the string-pieces be of soft wood there should be laid at the bottom of the groove a base, of hard wood board, an inch in thickness, to prevent the rail from settling into the string-piece more in one place than another; this is seen at *o*, fig. 1.

On the inner sides of the rail there should be a plate of iron let into the rail a quarter of an inch below the top edge, and made fast with screws; it being intended as a defence of the rail against the flanch of the wheel, it may not be required except on the outside rail at curvatures; or they may be thicker at curvatures, and thinner in other places. The plate should be about one inch wide, and one-sixth of an inch thick, varying according to circumstances; it is seen at *e*, fig. 1.

The groove should be payed with a heated mixture of tar and pitch, and the seams at the insertion of the rails filled, to exclude water and prevent decay. The string-pieces and the rail should be painted, after being well seasoned, with some coarse paint to protect them from the weather. The top of the rail should receive a coating of paint made thick with iron filings, iron sand, or some such substance, which will become firmly imbedded in the grain of the wood by the heavy tread of the wheels, and make a hard and durable surface, favourable to the adhesion of the wheels, so desirable upon an undulating road, and will last for a great number of years. The sawing of the rails, and the grooving of the string-pieces may be performed by machinery expeditiously; and the adoption of block-rails, fixed as above described, will lessen the expense of railways, so as to admit of their construction in many locations which will not justify the expense of iron rails. They will be found in most cases more economical than iron rails, as well in their first construction as in their use and maintainance for any given series of years.

What I claim as my invention, is the block-rail so formed as that the tread of the wheel shall be upon the end of the grain of the wood of which it is made, instead of upon the side of the grain; and the dowelling and confining the rail, and the top coating given to it as above described. I claim also the defending of the rail by a plate of iron, and the inserting a hard wood base for the rail to rest upon when the string-pieces are soft wood. I do not confine myself in the construction to the precise dimensions given, but claim any variation therein which the kind of timber employed, or the nature of the transportation contemplated, may justify or admit of.

JOHN RUGGLES.

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*Specification of a Patent for a machine for drying oil-cloths, such as are used for table covers, and granted to* DANIEL SAMPSON, *Winthrop, Kennebec county, Maine, May 30th,* 1837.

Instead of extending out the cloth in length for the purpose of drying it, after it has received the paint, I wind it round a shaft, spirally, in such a way that the painted side shall be fully exposed to the action of the air whilst it is at the same time prevented from coming into contact with the contiguous coil, or with any part of the machine.

I construct two shafts, or cylinders, of sufficient length to have the painted cloth wound upon them, and mount them in a suitable frame parallel to each other. To wind the cloth on these cylinders I prepare a band of slats, which slats are united together at the ends by webbing, or by a leather or other strap of any convenient width. The slats are placed at any suitable distance apart, say one inch, and they must be of such length as to allow the cloth to lie upon them widthwise, between the connecting straps. The straps must be raised above the slats to a sufficient distance to allow a space for the cloth, which will prevent its painted surface from coming into contact with the contiguous slats, when wound. For this purpose I put between the strap and each slat, a thickness of sole leather, a small block of wood, or other suitable material.

The band of slats may be fifty or sixty feet in length, or longer if desired, and their ends are fastened respectively upon the two cylinders above named. When the painted cloth is to be operated on, the whole band of slats is first wound on one of the shafts; the end of the cloth is then attached to one of the slats, or to the shaft upon which it is to be wound; this shaft is then turned by a winch, or otherwise, as the paint is spread upon the cloth, and it is thus received and retained upon the slats and suffered to remain there until the drying is completed.

What I claim as my invention is the construction of a machine such as I have herein described, in which oil cloth is wound upon a shaft or cylinder, by the aid of a continuous band of slats, for the purpose of being dried, substantially in the manner set forth.

DANIEL SAMPSON.

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*Specification of a Patent for an improved mode of manufacturing Saddle Trees, of all descriptions; granted to* WILLIAM KELLY, *White Deer Township, Union county, Pennsylvania, May 30th,* 1837.

To all whom it may concern, be it known, that I, William Kelly, of White Deer township, Union county, Pennsylvania, have invented an improved mode of manufacturing saddle trees, of all descriptions; and I do hereby declare that the following is a full and exact description thereof.

My improved mode of manufacturing saddle-trees consists in the substitution of raw-hide, for the wood usually employed for that purpose, to effect which, I proceed in the following manner. After the hair has been removed from the hide, in the usual way, and the hide is properly broken, I draw, or strain it, whilst wet, either over a wooden saddle-tree, or over a mould properly shaped and prepared for that purpose, where it is to remain until it is perfectly dry and hard. Having in this way brought two, or more such pieces of hide into the proper form, I unite them together at their edges, by means of rivets, or otherwise; preferring, however, the emplovment of rivets to any other mode. The pieces of hide are, of course, cut to the proper size and shape for the intended purpose. I sometimes form the tree, or foundation of the saddle, of a single piece of raw-hide, in which case I turn the edges of the hide over, all round the outer and inner edges of the tree, and rivet through the double thickness. To this foundation, or tree, the irons usually employed may be fastened, as to trees of wood. Strips of spring steel, also, may be riveted on, whenever it may be deemed requisite, so as to increase the stability and elasticity of the whole: I usually affix such a spring all around the under side. After my tree, thus made, has received its proper form, and is ready for covering, I give to it a thick coating of any good water proof varnish, such as shellac, copal, or gum-elastic. In finishing the saddle any of the known modes of procedure may be adopted, according to the fancy or judgment of the workman.

All that I claim as my invention, is the forming of the trees, or foundations, for saddles, of all descriptions, from raw-hide, instead of using wood, or other material, for that purpose, as herein fully set forth.

William Kelly.

## English Patents.

### *Improvement in Locomotive Engines.*

*Specification of a Patent for an improvement in Locomotive Engines, granted to* Thomas Elliot Harrison, *of the county of Durham. Enrolled June* 21*st*, 1837.

According to the common modes of construction, in the event of the boiler, the machinery, or wheels getting out of order, and requiring repairs, the engines, boilers, and indeed the whole combined machine is obliged to be laid up and become useless, till such part is repaired; and further, in order to get at the parts so requiring repair, many joints and parts of the locomotive-engines have, in most instances, to be taken apart, and in some cases the engine is obliged to be completely stripped; which causes very considerable cost, and puts out of use many parts of the combination not wanting repair. Now according to my invention, in case of any derangement taking place in the engines and parts connected therewith, the boiler and its carriage may at once be connected with another engine-carriage; and such is the case in respect to the boiler, should it or the parts directly connected therewith get out of order, and require repair, the engine-carriage may have such boiler and its carriage disconnected, and be applied to another boiler-carriage; hence much saving will be obtained in the working of locomotive-engines on railways, and fewer spare engines and boilers be required. According to my invention, the boiler of a locomotive-engine is mounted on four or more wheels, suitable for travelling on railways, and the engine or engines are mounted or carried on a separate and suitable carriage; and the various four, or more, wheeled carriages for the boilers and the carriages of the engines being capable of connection when they are to work together, and there being some spare boiler-carriages and spare engine-carriages on a line of railway, in case of a boiler or its carriage getting out of order, or in case of an engine-carriage getting out of order, it will not be necessary, as heretofore, to lay up the boiler and engines; but the one or the other will, in most instances, be capable of being used, on being connected with a fresh boiler-carriage, or engine carriage, as the case may be.

In a locomotive-engine combined and arranged according to my improvements, the boiler is mounted on a carriage with six wheels, which is a very desirable number, when the length of the boiler is such as to require support to that extent, though under other circumstances four wheels may be employed. The construction of the boiler is of that kind which is very commonly employed on the various railways now working, and is an arrangement of boiler well understood, and consequently in itself forms no part of my invention; nor do I confine myself to the use of the precise form or construction of steam boilers, as it will be evident that variations may be made. The supply-pump to the boiler may be worked by an eccentric on the axis of one of the pairs of wheels, or by any other convenient means. The two steam engines or cylinders are affixed horizontally to their carriage, which is carried, by four wheels; but I do not confine myself to the use of that number.

For conducting the steam from the boiler to the engines, and from thence to the chimney, two ball and socket-joints are used, the one attached to the boiler, the other to the engine-machinery. To make these ball and socket-joints steam-tight, they are packed after the usual mode of packing, being pressed against the ball by segments, which are firmly pressed upon the packing by screws acting upon them from the outside. It will be further necessary to have between the ball and the sockets joints, described above, a double-sliding stuffing-box, to allow for elongation. The above description refers to a means of conducting the steam from the boiler to the cylinders, and a similar arrangement will be necessary to conduct the exhausting steam from the cylinders to the chimney. The tank for containing the water to supply the boiler may be fixed upon the engine-frame, or above the framing, and a connexion formed between it and the feed pumps by a hose, as is now done between the tender and pumps of the ordinary-engines. The fuel for the supply of the engine may be carried upon the boiler-frame.

Having thus described the nature of my invention, and the manner of carrying the same into effect, I would have it understood that what I claim as my invention is the separating a locomotive engine for railways into two carriages, one for the boiler, and the other for the engines, each carriage having four or more wheels, whereby in case of derangement of the boiler-carriage, or engine-carriage, the other may be connected with a spare or other engine-carriage or boiler-carriage, as the case may be. Great facility is thus offered for the making of repairs, or for replacing new boilers to the boiler carriages; and by this means much saving of expense will result in the working of locomotive-engines on railways, as above described.

Repertory Pat. Inv.

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### *Abstract of the Specification of Mr. Samuel Hall's Patent Paddle Wheel.*

Fig. 1.

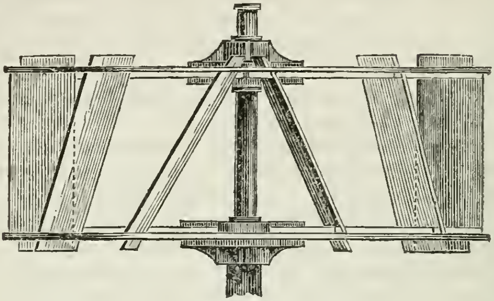
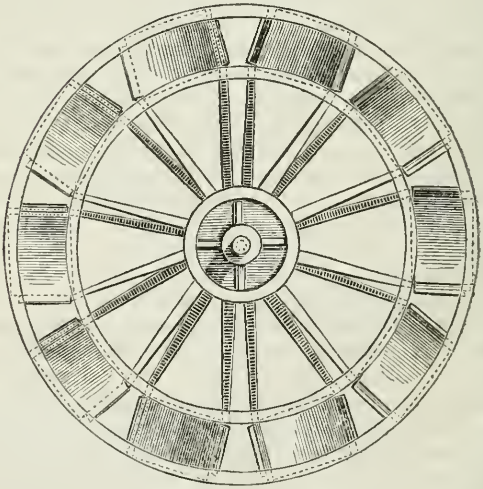


Fig 2.



Mr. Samuel Hall, whose important improvements in steam engines have given celebrity to his name, took out a patent on the 24th of June, 1836, for "improvements in propelling vessels; also improvements in steam engines, and in the method or methods of working some parts thereof." The improvements in propelling vessels consist in the paddle wheel, of which the following is the exposition given in Mr. Hall's specification.

The object of my invention, as regards the propelling of vessels, is to reduce the tremulous motion of steam vessels and decrease the back water caused by common paddle wheels, without impairing the propelling power.

The manner in which this part of my invention is to be performed is shown at figures 1 and 2 of the annexed drawing, and consists of a mode of affixing the paddle boards to the paddle wheels, whereby during one half of the revolution of each paddle wheel the water shall be put in motion in one direction, and by the other half of the revolution the water shall be struck and put in motion in another direction, so that the paddle boards shall be constantly striking in an oblique direction against currents of water produced in different directions by the paddle boards themselves; this I effect by placing about half of the number of the paddle boards on the wheels in a diagonal position, so as not to enter the water in a line parallel with its surface, but diagonally in one direction, and by placing the other half of the number of the paddle boards so that they shall enter the water in the reverse diagonal direction, as shown by the annexed drawings. Figure 1 is a side elevation, and figure 2 an end elevation of a paddle wheel having my improvement applied; from these figures it will be seen that the paddle boards, instead of standing at right angles to the rims of the wheels and parallel to the axis of the wheel, as in wheels of the ordinary construction, are placed obliquely to the rims and to the axis of the wheel. The angle which the paddle boards should form with the axis may vary from 30° to 60°, but I prefer the mean of these two angles, viz., an angle of 45°. I have already stated, and it will be seen by the figures 1 and 2, that the paddle boards do not all incline the same way, but that half of the number incline in one direction, and the other half in the opposite direction. In large paddle wheels the oblique positions of the paddle boards may vary four times in the revolution of the paddle wheels instead of twice.

As relates to my improvements in propelling vessels, I do not lay claim to the use of paddle boards entering the water in a diagonal or feathering direction, that not being new, but I claim as my invention the making of about one half of them to enter the water in one diagonal direction, and the other half to enter it in the reverse diagonal direction, or in large paddle wheels in making the boards to change their direction of entering into the water four times during the revolution of the paddle wheels instead of twice; thus about a fourth part of the paddle boards may enter the water in one diagonal direction, the next fourth part or thereabouts may enter it in the other diagonal direction, and so on, changing their direction four times as above stated, during one revolution of the paddle wheels instead of twice. Lond. Mec. Mag.

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### *Specification of the Patent granted to* CHARLES BRANDT, *of Upper Belgrave Place, in the County of Middlesex, Machinist, for an Improved Method of Evaporating and Cooling Fluids.*—Sealed July 27, 1836.

The nature of my said invention consists in exposing the fluid to be evaporated or cooled, on a series of extended surfaces by means of endless webs or bands, or extended surfaces connected therewith, either, or both constantly moving through the fluid and through the natural or an artificial atmosphere, as the case may be. I hereby describe the manner in which my said invention is to be performed by the following statement:—

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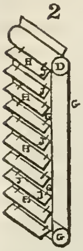

*Fig. 1*

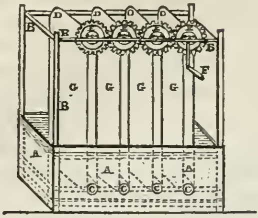

Fig. 1, is intended to represent a vat or tank of brewers' wort in progress of cooling by means of one modification of my said invention. A, A, A, A, is a vat-tank or reservoir of hot wort. B, B, B, is a frame to support the cooling apparatus. C, C, C, C, are four wooden rollers, which I call the lower rollers; and D, D, D, D, are four similar wooden rollers, which I call the upper rollers. E, E, E, E, are spur-wheels working into each other; and F, is a crank-handle fitted on to one, by turning which, motion is given to the whole. G, G, G, G, are four endless webs made of linen, hair-cloth, or other suitable substance. Now supposing the wort to be warm, but not sufficiently so to give off any perceptible vapour, if the handle F, is turned smartly round for a few revolutions, a dense steam or vapour will arise, and the temperature of the wort in the vat will be rapidly reduced. If the object be to evaporate rather than to cool, as for instance, in the process of evaporating brine in the manufacture of salt, then I make my rollers of any suitable metal or other material (dependent on the nature of the fluid to be evaporated,) and hollow, and introduce hot steam through both the upper and lower rollers, in order to heat the fluid in one case, and to drive it off in vapour from the web in the other, and in such cases I add to the endless web or band, leaves, or what I call surface-boards, or drip-leaves, as shewn in fig. 2, which represents one upper and one lower roller only of the apparatus, which will, when complete, be composed as before of a series of several. G, G, is the endless web as before. And the parts, similar to that marked H, are thin leaves of wood or metal, or other suitable material, sewed, laced, or otherwise hinged on to the web, and furnished with check-strings, as at J, J, J, by which a proper angle is preserved, as here shewn. As these leaves, which I call drip-leaves, are carried round by the web, a very extensive surface of the fluid is exposed for evaporation, which the constant dripping from the drip-leaves greatly promotes, and if the operation be performed in an artificially heated atmosphere, the result will be very rapid evaporation.

Reperl. Pat. Inv.

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## Progress of Practical and Theoretical Mechanics and Chemistry.

### *On the Smelting of Iron with Anthracite Coal.* By G. Crane.

On Monday, the first day of the meeting, the following communication "On the Smelting of Iron with Anthracite Coal" was made by Mr. George Crane, of the Yniscedwin Iron Works, to the Chemical Section of the British Association.

The great extent of the deposit of that description of fuel called anthracite, or stone coal, in the Mineral Basin of South Wales, accompanied, as it is, with iron mine in great abundance, and of good quality, has long made it an object of great interest to parties connected with that district, to discover some method of applying that description of coal to smelting purposes. One of the earliest patents enrolled in this country for this object, was that of

Mr. Martin, in 1804. From the mode detailed in his specification, there does not appear to have been any peculiarity in his process; he evidently expected to have succeeded in using this fuel by the only mode of blowing a furnace then known, that by cold blast. Another patent was taken out about twenty years afterwards, for a mode of forming a conglomerate coke, composed partly of the small of the anthracite veins, locally called culm, with a sufficient portion of the small of the bituminous, or binding veins, to cement the whole, when coked in an oven together; had this latter plan been attended with success, its application would of course have been limited to those localities where the two descriptions of coal were to be found near each other.

The Yniscedwin Iron Works, which are in my possession, are placed upon the anthracite formation. Until I discovered the method of applying this particular description of fuel to the smelting of iron ore, I was obliged to avail myself of the coal of the bituminous veins, obtained from the adjoining parish of Rillybebill, for the supply of the blast furnaces at Yniscedwin. During the fourteen years in which I have been engaged in the iron trade of South Wales, I have had my attention anxiously directed to the application of anthracite coal to smelting purposes, and at different periods, at a large outlay, tried a variety of plans, but without success, until the idea occurred to me that a hot, or heated blast, upon the principle of Mr. Neilson's patent, might, by its greater power, enable me to complete the combustion of this peculiar coal. I have now the pleasure of reporting to this meeting, that I have completely succeeded in the application of anthracite to the smelting of ironstone and ore.

That I have used no other fuel in a cupola blast furnace since the 7th of February last, and that the success of the experiment in the combination of hot, or heated air, with the coal in question, as fully detailed in the specification of my patent of improvement, enrolled in March last, has been in every respect of so satisfactory a description, whether with regard to the quantity of the iron produced, the quality of such iron, and the economy of the process, that I am now, and have been for the last three months, actively engaged in making the necessary preparations for the introduction of anthracite coal, instead of the coke of the bituminous veins, upon the whole of the blast furnaces which I at present have (three in number) at the Yniscedwin Iron Works: that I have renewed all my mineral takings in the anthracite part of the basin for ninety-nine years, and that I have arrangements in contemplation for a large extension of the works, in consequence of the perfect success which has resulted from the experiment.

One of the three furnaces at present on my establishment, is a small cupola furnace, which we call No. 2, built from the top of the hearth with firebricks only; this cupola is of the following dimensions:—Forty-one feet in its whole height; ten feet and a half across the boshes, and the walls of the thickness of two nine-inch bricks; the hearth three feet six inches square, and five feet deep. The two other furnaces, which we call No. 1 and No. 3, are thick stone-walled furnaces. Some years since I found that this cupola furnace, No. 2 had, on the average of a long period (I concluded from the smallness of its dimensions and the thickness of its walls,) taken so large an excess of minerals to the ton of iron produced, when compared with the quantity taken on the average of the same period by the stone-walled furnace, No. 1, standing within fifty feet of it, that I determined to erect a second furnace, similar to the latter one, in lieu of it.

The meeting will shortly understand why I am giving these details, which may at the moment appear not to be very interesting particulars. This cupola furnace, No. 2, not being at work when I arrived at the determination to try the experiment of the combination of the hot blast and anthracite coal upon the large scale, it was more convenient to put this furnace into blast for the purpose, rather than to interfere with the usual progress of my business by experimentalizing in either of the two other furnaces. The cupola furnace, No. 2, from the causes which I have before explained, had on the average of a long period taken cokes, the produce of five tons and three cwt. of coal to the ton of pig iron, when the stone walled furnaces had not required cokes to the ton of metal produced, quite equal to four tons of coal. The consumption of ironstone and limestone had been greater in the former than in the latter description of furnace, but not to so great an extent.

I will make one other explanatory remark on this part of the subject. The two descriptions of furnaces have worked in so different a manner with the minerals of my neighbourhood, that whilst the barrow of cokes, weighing about three and a half cwt., would take, when consumed in either of the stone-walled furnaces, a charge or burden of five to five and a half cwt. of calcined iron mine, of the descriptions obtained in my neighbourhood, according to the kind of iron which I was desirous of producing, the same barrow of cokes in the No. 2 cupola, or thin-walled furnace would only carry from three to three and a half cwt. of calcined mine of the same kind. Under these disadvantageous circumstances, I have actually produced from the No. 2 cupola furnace the ton of iron in the smelting process, on the average of three months, with less than twenty-seven cwt. of anthracite coal. The heating of the blast, and the calcination of the mine require, of course, upon my plan, the same quantity of fuel, which is necessary for the like processes in other establishments.

With regard to the quantity of iron produced, the result which I have to report is equally satisfactory. I must not, however, omit to mention that for the greater convenience of filling this cupola furnace, No. 2, from an adjacent gallery, previous to the commencement of my anthracite experiments, I raised it in height from thirty-six feet six inches to forty-one feet; this might have had *some* effect upon reducing the excess of the consumption of fuel when compared with that which had taken place in the No. 1, and might have increased its power of smelting with my blast of one quarter pound upon the square inch pressure, only from its former average of twenty-two tons to twenty-four. Since I have adopted the use of anthracite coal combined with hot air, my make in the No. 2 cupola furnace, with the same pressure of blast only, has ranged from thirty to thirty-four and thirty-six tons, and one week we actually tapped within three cwt. of thirty-nine tons of grey iron from this furnace; its present weekly average may be expected to range from thirty-five to thirty-six tons.

With respect to the quality of the iron produced by the combination of hot blast and anthracite coal, the result which I have to communicate will be very satisfactory; it is well known in my neighbourhood that my cold blast iron for all purposes, where great strength was required, was never deemed inferior to any smelted in South Wales; that which I have hitherto produced with hot blast and anthracite coal is, however, decidedly stronger than any other before smelted at the Yniscedwin Iron Works.

Relying upon the representations of chemists, that anthracite coal is almost entirely composed of pure carbon, I have always indulged the hope, that in the event of my ever succeeding in discovering a method of applying this fuel to smelting purposes, that I should be able to produce a quality of iron not very dissimilar to that formerly obtained by smelting with charcoal; how far this expectation will be realized further experience must prove; but, as far as my experience of the quality of this particular description of iron up to the present time has gone, I am sanguine with respect to the result. I shall be happy at any time to offer every facility in my power to any parties who may be deputed by this Association, or by any other scientific body, to thoroughly investigate this important subject.

If I have not trespassed already too long upon the time of the Section, its members may not be uninterested in being informed in what manner the idea first occurred to me of applying an heated blast to anthracite coal. One evening after I had placed a piece of it upon my parlour fire (which had before been made up with bituminous coal,) and had allowed it to arrive at a red heat, upon my applying as fierce a blast to this piece of coal as I could raise from a pair of bellows, I noticed the appearance of a black mark or spot upon that part of it where the air impinged upon it; on my continuing the like rapid current, in the same direction, I shortly blew the fire out of it. I at once perceived that the effect of the strength of the current of air, when cold, which we of necessity are obliged to blow into our furnaces to secure the passage of the blast through the high and dense column of materials contained in an erection like a blast furnace, instead of encouraging ignition, was actually unfavourable to it. On giving the thing but a moment's reflection, the question promptly occurred to me, What would be the effect of turning a blast into a furnace upon this coal, which would itself burn—which would itself melt lead? I at once determined that it was a thought which was really worthy mature reflection. The further consideration which I gave to the matter, and the further experiments which I shortly afterwards instituted, (which were continued at a great expense for some months,) have at length been crowned with the full success which I have now had the pleasure of reporting to this meeting.

The anthracite formation probably occupies about one third of the Mineral Basin of South Wales; it commences near the upper part of the vale of Neath, in the county of Glamorgan, and proceeds in a westwardly direction through the remainder of that county, thence through that of Carmarthen, and crops out, (as I am informed,) in the sea, in St. Budes Bay, after passing through a considerable portion of the county of Pembroke. It is likewise to be found in France, Austria, Bohemia, and Sardinia, in the Old World; and very large deposites of it have been already discovered on the continent of America, particularly in the state of Pennsylvania.

Proceedings of the British Association.—Mining Journal.

## *Improbability of explosions in Steam Boilers by the generation of Hydrogen Gas.*

Although the question of the production of hydrogen in a steam boiler when suddenly replenished with water while the metal is in a state of incandescence, and consequent explosion from a mixture of the inflamable gas with atmospheric air was treated with sufficient clearness by the committee of the Franklin Institute, as may be seen by a reference to the report, (Jour. Frank. Inst. Vol. XVII, p. 217.) Yet as danger from such a source has been much insisted upon and may still be apprehended by some who have not taken the trouble to read that report, it may not be unadvisable to introduce the opinion of an able engineer, given in testimony before the proper authorities at Hull, in consequence of the disastrous explosion of the Union Steam Packet, at that place. Not knowing at what period precisely, this evidence was taken, we cannot judge of the possibility of the witness having seen the report of the Franklin Institute. His opinions coincide with the conclusions of the committee, and in reference to the results thus experimentally obtained, we may adopt the words of a writer in the London Mechanics Magazine, June 17th, 1837;—"in fact, the report altogether ought to be studied by every one having the responsibility of the direction of a steam engine, and human life in his care."

A verdict of manslaughter was rendered by the jury, against the engineer, in the case above referred to. G.

*Mr. T. J. Pearsall** stated—"I have considered the subject of the explosion of the boiler of the Union. In my opinion it could not have taken place had the boiler been sufficiently supplied with water, unless the steam generated was prevented escaping by some very great force, which should hold the safety-valve fastened down or obstructed. I consider the immediate cause of the bursting of the boiler to have been the expansive power of steam, because steam is capable of producing any such effects. I am most decidedly of opinion that it did not arise from gas. My reasons for that opinion are that although water is decomposed readily by red-hot iron, yet it reqoires that the surface of the iron should be in a metallic state; a new boiler is nearly in that condition, but not quite so; there is just the chance that if a new boiler were employed, and very pure water admitted in small quantity, so as to allow portions of the boiler to become red-hot, then water might become decomposed; but such circumstances would at the same time be sufficient to generate an incalculable amount of steam. Such explosion, therefore, would arise from mixed causes—such as the presence of the gas, and the enormous amount of steam, and its great pressure. I cannot suppose a case where such decomposition of water and evolution of gas would take place, where such water is employed as that of the Humber, or as that furnished by the Ocean. Such gas would not be inflammable of itself,—there must be the presence of atmospheric air or oxygen, and of flame, or a substance heated to a very high degree.

"I can scarcely imagine such an explosion in a boiler, because there must be also a mixture of oxygen with hydrogen in proper proportion. I cannot conceive in what manner atmospheric air could gain admission to the boiler the pressure of the gas from within being greater than that of the air from without, and the aperture which would admit the atmospheric air would allow the escape of the hydrogen. Hydrogen gas would operate upon the safety-valve in the same manner as steam. *I know not one single instance of one particle of evidence of the presence of hydrogen in a boiler.*

"When a boiler has been at work some time, and becomes incrusted with saline and other earthy matter, it is quite contrary to all known chemical principles, to suppose that water can be decomposed by such earthy substances; it is quite hypothetical to suppose that it can be so decomposed. I do not know that under any circumstances water could be resolved into its two elements—hydrogen and oxygen—by heat alone. In all cases the quantity of hydrogen generated must be very limited compared with the amount of steam formed by the high temperature. I would say that if hydrogen were in the boiler, and oxygen were to gain access, the hydrogen would escape by the same means as the oxygen entered; the pressure of all gases is the same when generated, and it is impossible to conceive that hydrogen should have less pressure than that of atmospheric air at the same temperature. It would require a very large portion of the oxygen of the atmosphere to be in contact with the hydrogen in the boiler to cause an explosion. In 100 parts of atmospheric air there are only about 20 of oxygen, and it is that alone which is required to explode the hydrogen, the nitrogen of the atmosphere having only the effect of diluting it. A possible introduction of air into a steam-boiler may be that of the air contained in the water itself, which may be evolved when the water is boiled, but this quantity of atmospheric air is very small, about four per cent. of the bulk of the fluid water, and not so much air as that can be obtained from sea water. In round numbers one cubic inch of water will afford 1700 cubic inches of steam, which, decomposed at that temperature, expands into thrice its volume of gases, two-thirds being hydrogen gas, requiring about 17,000 cubic inches of atmospheric air for full and rapid combustion, while the original cubic inch of water only gave off one-twenty fifth of its bulk of air.

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*This gentleman was a pupil of Prof. Faraday,—was several years the assistant, in the Royal Institution, of that eminent investigator, and has recently retired from the Professorship of Chemistry in the Medical School at Hull, to direct the manufactures on a large scale, which eminently depend upon that science.

"If safety-valves be of the proper size, and steam be raised gradually, the valve will operate; but if you raise an enormous amount of steam at once, or under extraordinary circumstances, and wish it to be at once discharged, such circumstances, as when you have too little water, and portions of the boiler be red-hot, and by a motion of the vessel any sudden evolution of steam is caused, then the valve will be rendered comparatively useless or dangerous. I consider steam capable of producing an explosion such as this. I know of no greater explosive power than steam, except gunpowder. Perkin's patent gun, in the Adelaide Gallery, daily throws off a number of balls per minute by steam; and if gas be produced by means similar to those alluded to, it must be produced in the instance of Perkins's gun; had the explosion been caused by gas, it must have been accompanied by a very vivid flash."

Mag. Pop. Sci.

## *Advantages of Anthracite coal in the Hot Blast Furnace.*

At a meeting of the Royal Cornwall Polytechnic Society on Wednesday, Oct. 11, Mr. R. W. Fox stated that he had received that morning, a paper from a relative of his in Wales, Joseph T. Price, Esq., from which the following are extracts:

"Our experiment at Neath Abbey has shown that, by combining a portion of bituminous coal, coked in ovens with a portion of anthracite, 20 cwt. of cast iron may be made by 33 cwt., $\frac{3}{4}$ths of the former, $\frac{1}{4}$th of the latter.—The iron made by using the hot blast is generally more tender, more lead-like, and more easily broken, than when coke or bituminous coal only is employed. By the use of the anthracite in the proportion stated, and also without any mixture of bituminous coal, it is materially stronger, and I should say better, and really more valuable as a marketable article, and for the uses to which it is applicable.—Our experiments are only commenced, I am, therefore, not prepared to state more than very general results.—When complete success had attended the use of the quarter part anthracite with three-quarters part of bituminous coke, we put on the furnace half of each. The result was that the change checked the make of iron one-half nearly—40 charges of iron-stone, coal, and coke, in twelve hours were reduced to 20 by it, and consequently the yield of iron proportionately. However, we quickly returned to the quarter anthracite, and three-quarters coke." The letter went on to state that the advantages already obtained were a diminished consumption of fuel, and an improved quality of iron. The precise degree of improvement could only be generally stated at present.

Mr. Price proceeds to say—"I transmit a specimen of anthracite iron, made at Neath Abbay; I call it anthracite iron, because it was enriched and its nature strengthened, by a mixture of about a quarter part of anthracite, or stone coal with three parts of coke, made in ovens from bituminous coal. — Before I close. permit me to offer through your society, a premium of ten guineas, for the best experiments, on the strength and tenacity of Anthracite Cast Iron, 1st and 2nd fusion, distinguishing the proportion of each kind of coal used, as compared with the strength and tenacity of Welsh, Scotch, and English cast iron of parallel qualities, 1st and 2d fusion, made with ordinary coal or coke, to be accompanied by a well-attested statement of the proportion of coal, anthracite, or stone-coal, and of the kinds of mine-ore and flux, used in the manufacture of each."

Mr. Fox then stated an interesting fact, mentioned to him by a gentleman from the Brazils, who had been engaged extensively in mining; that the veins there, as here, run north and south, exemplifying the magnetic power and the magnetic meridian. He said it might be remembered that he last year exhibited some specimens of copper ore, which had been altered by long-continued electrical action. He now produced some specimens of clay, in which veins and insulated portions of copper had been formed by the same agency. They were formed in masses of clay separating the copper ore from the zinc in the manner which he had heretofore described, and in which the electric action had long continued. He had also to lay before the meeting some clay which by means of the same agency had assumed the laminated appearance of clay slate. (These specimens were then produced to the meeting.) Mr. Fox proceeded to say that it was not a little gratifying to him to present to the society such strong evidence in favour of those views; and which appeared to him to be no longer questionable, at least as regarded the *laminæ* of clay-slate, and other rocks of a corresponding structure; and he thought it not improbable, that similar evidence might ere long be obtained, that the symmetical joints of rocks are due to similar agency.—Thus it appeared, he said, that the structure of rocks had a direct tendency to confirm the theory which he had endeavoured to put forth relative to the formation of mineral veins: and the facts which from time to time had come under his notice, had tended more and more to satisfy him of the influencial agency of electricity in their production. Indeed, he believed, that the structural and relative characters and qualities of coal-beds were also connected with chemical action.—Several other gentlemen then addressed the meeting, and some premiums announced for the next year.—Subscriptions were entered into to enable the society to build a gallery.

But one feeling prevailed on the occasion of this meeting, and that was one of high gratification at witnessing the important benefits which this society has already conferred on this county in particular, and on the country in general. The committee and every person connected with its management deserve the warmest approbation.

Lond. Mec. Mag.

## *Mica as a Substitute for Glass.*

This beautiful substance, which may be termed elastic glass, is capable of being appropriated to many useful purposes, to which it has not been hitherto applied, except by one or two individuals. One reason for the apparent neglect of this most beautiful and unique mineral may have been its scarcity in this country. We have frequently purchased it at the rate of twenty and twenty-five shillings a pound, whereas it may be imported at one third the sum. We believe that a considerable portion of the mica imported into England is required for a new kind of stove, which we, however, have never seen in operation. It is used also in the construction of cards of magnetic compasses, as it has the peculiar property of always preserving its plane, so that when pasted to the under surface of the card, it prevents it from warping.

Several years ago we applied mica to a new and very useful purpose, for which it is particularly adapted, and we should have publicly recommended its adoption, had not gas lights almost entirely superseded the Argand Lamp. As glasses, however, are often used with gas burners, we take the opportunity of stating, that in order to convert the mica to this purpose, it should be split as thin as possible, and then bent round into a cylinder, the edges lapping over each other a little, and secured by a thin slip of brass rivetted to the mica. It is infinitely preferable to glass for this purpose, as it is neither liable to break nor to be burnt.

There is another most important use for which mica is peculiarly adapted, although we have never heard of its having been so applied. We advert to its substitution for glass in hot houses, as the substance, from its elasticity, would endure the most tremendous hail storms, which are often known to destroy hundreds and thousands of glass panes. Mica has long been used as a substitute for horn in lanterns, and the application is judicious, as independent of its superior transparency, it is not liable to be destroyed or even affected by contact with the flame, which would blister and destroy horn. We are not aware that mica has ever been used for the slides of the magic lantern, but it is preferable to glass, because independent of its elasticity, it admits of having the figure drawn and colored with more facility than glass.

We have also succeeded in silvering mica, so as to form very perfect and elastic mirrors, which may be carried in a pocket-book.

Having occasion for a cylindrical mirror, for that beautiful optical instrument for restoring distorted images to regular figure, we found mica particularly adapted for our purpose, from the facility with which, after being silvered, it could be bent into a cylindrical form. We believe no name has been assigned to this elegant instrument, which has, however, been fully described in "Hooper's Rational Recreations," and in Priestley's large "Treatise on Vision, Light, and Colours," amongst the plates of which it is numbered 53.

We have tried some experiments with the mica, as a surface upon which to work with the graver or the etching tool, and we have long thought that it might be advantageously used in the lithographic process. If our conjecture should be well founded, it would be extremely acceptable to travelling artists, as they might make their sketches on the spot upon the leaves of mica, and afterwards pass them through the press. We have now before us a small copy of a well known picture of Wilke, printed in lithography, from a surface of mica, and we shall leave it at our office for the inspection of any scientific gentlemen who may wish to examine it.

A few days ago we met some very fine specimens of water colours upon mica, executed at Patna, in Hindostan; and as this use of the substance is probably new to the scientific gentlemen now in Liverpool, we have prevailed upon the gentleman who has the specimens, to leave some of them with Messrs. Wordley and Mayer, silversmiths, in Lord street, for the inspection of the curious. One of these specimens, representing Indian costumes, may also be seen in the window of our office. If the surface is suitable for oil painting, it would open quite a new field to our artists, especially our miniature painters, as the picture would at one process be painted and glazed. Mining Journal.

### *New Sand for Glass making.*

The silver medal of the Society of Arts was awarded for the discovery of a sand in the colony of New South Wales, eminently fitted for the manufacture of the finer kinds of glass.—The following notes on the subject are interesting:—In the year 1831 it was observed, that in many places between Sydney and Botany Bay the surface of the ground was covered by a remarkably pure and white siliceous sand, derived from the decomposition of one of the beds of sand belonging to the coal formation. Mr. King, of Sydney, the discoverer, being of opinion that this sand would be found peculiarly applicable to the business of glass-makers, forwarded eleven bags of the same to his agents, Messrs. Buckle, Baxter, and Buckle of London. These arrived in June, 1832, and some was put into the hands of Messrs. Pellatt and Co., of the Falcon Glass-house, for trial. In August of the same year they reported the result of their experiments. From their report the following is an extract:—"We find the sand from Sydney to be decidedly superior to any we have previously employed. The most esteemed property of this sand, and that which makes it of the greatest importance to glass-makers, is derived from the absence of oxide of iron and every other combination that would affect the colour of the glass when made. It is also free from insoluble matter. Glass made from this sand is more brilliant and watery than any other. We consider it fortunate at this period that this sand has been discovered, as the sand with which most glass-makers were supplied is now of very bad quality, and has been given up by many." According to an analysis of a sample of this sand, made conjointly with Mr. Children, of the British Museum, and Mr. Garden, it appears to consist of 95.0 silica, 2.2 sulphate of lime, 0.4 oxide of iron, with a trace of alumine--making 97.6; leaving 2.4 for organic matter, water, and loss, the whole will be 100.0. On application to Mr. Pellatt the following further particulars were obtained:—He says that the recent arrival of a few hundred weight of this superior silex had enabled him to make a second experiment, which turned out fully as well as the first. He is of opinion that the Sydney sand exceeds all others heretofore in use, for whiteness, brilliancy, and fusibility; and he has little doubt, should the freight be moderate, that this comparatively pure material will be imported in large quantities for glass-makers' use in this country. He had mixed it with the usual proportions of carbonate of potash and nitrate of potash, with a rather less proportion of manganese than other sands require. Mr. Pellatt adds, that he hopes soon to be able to report on the Sydney sand as regards flint glass-ware for optic plates. A few tons of the same kind of sand were lately imported into Liverpool, and were eagerly purchased, so that a considerable improvement in the qualities of the finer kinds of flint glass may soon be expected. Ibid.

### *On the action of Cold Air in maintaining heat.* By Robert Addams, *Esq.*

I was at Sheffield in last December, and then a Mr. Linley, bellows-maker of that town, showed me the following curious experiments: first, a rod of iron, about an inch in diameter, was heated at one end in a forge fire, up to a full white heat, then quickly withdrawn from the fire and exposed to a strong blast of cold air from a forge bellows; the iron immediately became so hot as to fuse, and the liquefied matter was blown off and burnt in the air with the scintillating appearance of iron wire burning in oxygen gas; and so continued to melt until a pound or more of the metal had been thus wasted.

Another mode of producing the same action consisted in heating a rod of iron, as before; but instead of a blast of air, it was tied to a cord, and by it whirled round in a vertical plane; thus by passing swiftly through the cold air it melted, and was thrown off in beautiful scintillations, appearing as luminous tangents to the circle in which the bar was moved.

I have since applied a heated bar of iron to the periphery of a revolving wheel, and by an including tin hoop or guard, it is thus made an interesting class experiment.

The cause of this augmentation of temperature is, I conceive, referable to the oxidation of the metal, which takes place freely under the conditions of the experiments here recorded. Then, as is well known, the formation of the oxide is accompanied with a great development of heat; and the cases before us are striking examples of the heating influence by chemical action predominating over the cooling effect of the air conjoined with the radiating force.

The success of these experiments chiefly depends upon having the iron at first of a sufficiently high temperature, and upon the velocity of the air from the bellows, or otherwise the velocity of the iron through the air. For the iron at a white heat is greedy of oxygen, which the air solidifies. Then the oxide thus formed requires to be blown or whirled off, in order that fresh surfaces of the *metal* may be exposed to the air.

When the blast is employed, we see the oxide fusing, and deep channels scooped out in the bar by the rushing air on that side where the current is directed. Lond. and Edin. Philos. Mag.

### *Iron Steam Vessels.*

The Rainbow, an iron steam vessel, built for the General Steam Navigation Company, has been launched since our last, from Mr. J. Laird's yard, at Birkenhead, near Liverpool. She is the largest iron steam vessel built or building in this country, her dimensions being, length over all, 213 feet; beam, within paddle-boxes, 25 feet; extreme width, 49. She is divided into six compartments, by five water-tight partitions, which entirely remove all danger of sinking in case of collision with other vessels; and if all the other advantages iron vessels possess are left out of view, the simple fact, that in them these partitions can be rendered most efficient and secure, will, we have no doubt, cause their general adoption, both for sea-going and river vessels. The Rainbow is now being fitted by Messrs. Forrester and Co., with a pair of ninety horse power engines; and her cabins, which are of the most spacious and elegant description, are also in a forward state. The Rainbow is the tenth vessel built by Mr. Laird, with water-tight compartments, and we understand that he has now three other large ones building on the same principle. We are induced more particularly to notice the launch of this vessel, as an iron steam boat, called the Sirius, lately launched at the Isle of Dogs, is wrongly stated in the *Railway Magazine* to be the longest yet made of iron. She measures only 164 feet in keel, and 176 on deck, with a beam of 17 feet. She will have two high-pressure engines of thirty-five horse power each, with twenty-four inch cylinders of three and a half feet stroke, and three boilers with copper tubes worked expansively. She is divided into four compartments, by three iron water-tight bulkheads similar to those of the Rainbow; but it will be seen, on comparing the dimensions we have given, that she will not bear a comparison with her northern rival. It is confidently expected that the Rainbow, from her superior model and light draft of water, will be one of the fastest vessels afloat. The Sirius is intended for the Rhone, and it is no difficult matter to see that these iron steamers are gradually becoming general.

Nautical Magazine.

## Progress of Physical Science.

*British Association, September* 12.—*Vegetable Physiology.*

Mr. Bowman read a paper from Mr. Gardner, "On the internal structure of the wood of Palms." The attention of Mr. Gardner, who is residing in Brazil, was directed to this subject by the remarks made by Professor Lindley, in his "Introduction to Botany." In order to test the truth of the theory of Mohl, he made several experiments on the palms in his district. He made a vertical section of a palm, four inches in circumference, and, by doing this, he could trace very plainly woody fibres proceeding from the base of the leaves to the centre of the stem, at an angle of 18 degrees; they then turned downwards and outwards to within a few lines of the external cortical part of the stem, running parallel with its axis. The distance between these two points was about two feet and a half. The fibres were traced quite distinctly up into the centre of the leaf. In answer to the questions proposed by Lindley in his work, the author stated:—1. That the wood of palms was always hard and compact outside, gradually getting softer towards the centre, the fibres of the upper leaves not descending to so great a depth as the lower. 2. The wood is much harder at the bottom than any other part of the stem, the inhabitants of tropical climates using only this part for economical purposes.

Professor Lindley observed, that this paper confirmed the views of the structure both of endogens and exogens, which had been increasingly embraced by botanists. In the first place, the views of Mohl on the structure of endogens were confirmed. There was, however, a slight difference between Mr. Gardner and Professor Mohl; the latter having stated that the woody fibres of endogens terminated *in* their cortical integument, whilst the former had traced them only within a few lines of this point. In the next place, the paper confirmed the theory of the formation of wood from the emanation of fibres from the leaves. Whatever might be the difference between the arrangement of the fibres of exogens and endogens, there could be no doubt that their origin was the same. Mr. Gardner had referred, in his paper, to the glandular disks on the woody fibre that were, at one time, thought to characterize the order Coniferæ. He would, however, draw the attention of the section to a fact that had lately been discovered, and not hitherto published, that these glandular disks existed on all the woody fibres of plants that yielded resinous matter. Brown first discovered them in the wood of Tasmania, *(Winteraceæ,)* and Griffiths had since demonstrated them in Spherostema, *(Schizandreæ.)*

Mr. Nevin detailed some experiments on vegetable physiology. The experiments were performed on elms forty years of age, in February, 1836.

1. The stem of the tree was denuded, in a circle, of its cortical integument alone, leaving the alburnum beneath uninjured. On the May following the denuded part was filled up by the exudation of bark and wood from the upper surface of the wound, and the tree had not suffered in growth.

2. The bark and *cambium* were removed in the same manner. In August 1837 this tree sickened, and there was no formation of wood or bark in the wounded part. Two developments, however, took place one above the other, from below; the former having the appearance of roots, the latter were branches with leaves.

3. The bark and two layers of alburnum were cut away. The tree was at the time unhealthy; it however put forth its leaves on that and the ensuing spring, but shortly after died. No sap was observed above or below the wounded part. Roots were developed from the upper, and branches from the lower part of the section.

4. The bark and six layers of alburnum were taken off. The tree became much less vigorous, but did not die, and otherwise presented the same appearance as the last.

5. The bark and twelve layers of alburnum were stripped. The consequences were again similar to the last two; the alburnum above and below the cut being dry, but an accidental cut that penetrated into the heart wood exuded sap.

6. This was a repetition of the experiment of Palisot de Beauvais, by cutting away a circular ring of bark around a single branch. The branch continued to grow, and roots sprouted from the under surface of the isolated bark and branch.

7. In this the whole of the wood of the tree was cut away, except four pillars, composed of bark and sap wood. In this case, the sap first appeared from above, descending by the pith, and then from the heart wood, the alburnum being dry. In this case the sap must have passed up the alburnum, and horizontally through to the heart wood.

Mr Nevin inferred from these experiments—1. That the life of the tree does not depend on the liber or cambium. 2. A descent of sap takes place before the development of leaves. 3. That new matter arises from below: which had not previously been allowed. He thought there were two distinct principles in the tree,—one, the ascending or leaf principle: the other, the descending or root principle. Mr. Nevin had also performed some experiments on the conversion of roots into branches, and came to the conclusion, that buds or branches might be developed from any part of the root above its extreme end, from which point it was impossible for buds to be developed.

Professor Lindley remarked that these experiments confirmed entirely the theory of the structure of wood adopted by Du Petit Thouars. He did not think that the existence of any new principle could be inferred from the experiments. In the seventh experiment the horizontal circulation of the sap was proved, and confirmed the accuracy of Hall's experiment of cutting a tree nearly through on alternate sides, when the sap still ascended. Lon. & Ed. Philos. Mag.

## *Artificial Production of Rubies.*

A few months since M. Guadin presented to the Academy of Sciences of Paris a note, in which he announced his having been able to produce rubies in considerable quantities by a process of which he has given merely a sketch.

In order to obtain these substances analogous to rubies, M. Gaudin uses a platinum blowpipe of a single piece, formed of two hollow concentric cylinders, communicating by one of the extremities, one with a reservoir of hydrogen, the other with a reservoir of oxygen; the two other extremities are pierced with convergent openings, so as to effect in a great degree the mixture of the gases.

It is well known that alumina is fusible with the oxygen and hydrogen blowpipe; but no one before M. Gaudin had endeavored to melt this earth into globules several millimetres in size. Having submitted a piece of potash alum to the action of his blowpipe, he obtained a perfectly round and limpid globule. The platinum tube being perforated and melted at several places, he obtained after the cooling, instead of a limpid spheroid, an opake elongated globule, and covered internally with crystals, which may be referred to the cube or to the rhombohedron. These crystals scratch rock crystal, topaz, garnet, and spinelle; with regard to hardness, therefore, they agree with the ordinary ruby. They appear to be composed solely of alumina, the potash votalizing at the high temperature to which the alum is submitted.

Having obtained an apparatus stronger than the one first used, he made an experiment with some ammoniacal alum mixed with from 4 to 5 thousandths of chromate of potash; the whole being previously calcined, he gave it the form of a spherical cup, in order to obtain a maximum effect, by directing the flame to the concave part. In a few moments the inner surface of this cup was covered with globules of a beautiful ruby red colour, slightly translucid, and some of which exhibited the form and cleavage of the ruby.

M. Malaguti, who had occasion to analyse these globules, found them to be composed of 97 parts alumina, one of oxide of chrome, and two parts of silica and lime; which composition is analogous to that of the ruby. Comptes Rendus, August, 1837, p. 325. Ibid.

## *A New Organic Acid.*

M. Peligot has read to the Academy of Sciences some observations on cane sugar, and on a new acid derived from the action of alkalies on sugar of starch.

It is well known that there exist two distinct varieties of sugar; one of them is common sugar, extracted from the cane, beet root, and the maple; the other occurs in grapes and diabetic urine, and is formed when starch, lignin, or sugar of milk is treated with dilute sulphuric acid. It is also known that, influenced by various circumstances, common sugar may be converted into sugar identical with that of starch.

Among the differences which exist between the two kinds of sugar, one of the most prominent, (says M. Peligot,) is in my opinion that which is observed when these bodies are put in contact with alkaline bases.

Common sugar, when added to potash, lime, or barytes, combines with these bases, and acts towards them the part of a true acid*: by boiling a mixed solution of barytes and sugar, I obtained by direct action a crystallized compound of these two bodies; the analysis of saccharate of barytes, and other analogous salts, proves that the sugar does not undergo any particular modification: on decomposing the saccharates by weak acids, the sugar re-appears with its usual properties.

The case is entirely different with sugar of starch; the alkalies effect an essential alteration in it. On putting lime or barytes into a solution of this sugar, even cold, I observed that after a certain time these bases had lost their alkaline properties, and were saturated with a new and very powerful acid, which is formed by simple contact with the sugar, and which immediately unites with the alkalies, and forms perfectly neutral salts. This acid may be still more readily obtained by putting dry sugar of starch, fused at 212°, in contact with crystallized hydrate of barytes. Vivid re-action takes place almost immediately; the mixture swells, the temperature rises very much, and in a few seconds the sugar is transformed into acid. The barytic salt is then dissolved in water, and the acid is precipitated by means of a solution of subacetate of lead, to be gradually added, in order first to separate a brown colouring matter which arises during the re-action, at least when operating in contact with the air. The last precipitate obtained is colourless, and contains the acid in a state of subsalt; it may then be separated by the usual means.

Besides this acid, another non-volatile body is produced, which possesses the property of immediately reducing, when cold, the salts of silver and of mercury.

The very easy formation of an acid, by the contact of sugar of starch or grapes, with bases, (M. Peligot observes,) shows how proper it is to avoid the employment of too much lime in the purification of the beet root juice; for although lime does not alter the sugar, it acts, when in excess, upon the sugar analogous to that of grapes, into which common sugar is easily converted by the influence of heat, acid, or fermentation. There are therefore two difficulties to be avoided; these may be apprehended at the same time,—the intervention of acids which decompose the sugar intended to be extracted, and the effects of the alkalies which act upon the sugar of starch resulting from this decomposition.

L'Institut, Août, 1837. Ibid.

*See London and Edinburgh Philosophical Magazine, Vol. XI, p. 152.

## Progress of Civil Engineering.

### *On a peculiar form of Rail, and the construction of Railways in America and Germany, by* Herman Koehler, *of Leipzig M. Inst. C. E.*

The pattern, which the author describes, is by American engineers called the inverted T rail, (⊥), and was introduced in order to avoid trouble and expense, which railways are liable to where the rails are placed in chairs and fastened with keys. The material used for this need not be of first quality, but in cases where it is expedient to support a general confidence in the quality of the iron, good and sound rails can be made of ⅖ths of No. 2, Welsh iron, and ⅗ths of No. 3, employing the better quality for the head and bottom, and No. 2 for the stem of the rail, rolled in such manner that the lamina of the iron lie horizontally throughout.

The experience of all railways seem to confirm the opinion that chairs and keys to keep the rails firm to their places, are a great and expensive inconvenience, and a dangerous construction, whether wood or iron be the material of the keys. The author then details the advantages of the rail, especially if laid on a continuous line of stone or wooden sleepers at a small distance apart.

Wooden railways are at this time used in Germany, and the author has laid 9 miles between Leipzig and Dresden. Wooden sleepers, 8 inches square, are placed upon trenches cut across the embankment at every yard, and filled up with a bed of broken stones, one foot deep. Notches 3½ inches deep are cut into these cross ties to receive the wooden rails of 6 by 9 inches, which are shod with iron plates of one inch thickness and 2½ inches width. At their joints they are put together on iron plates ⅛th of an inch thick, to prevent their being pressed into the wood. The rails are wedged firmly to the sleepers by wooden wedges. The head of the spikes with which the iron rails are fastened to the wood are of a conical form and fit into corresponding holes, these having an eliptical form to prevent the spike from being drawn or bent on the contraction or expansion of the iron rail. The ends of every iron plate rail are fastened with screw bolts, passing through the whole height of the wooden rails, holding them firmly to their places, which is a very important precaution, as the engines are apt to catch the points of the plate rails with their wheel flanches and to run off.

Trans. Insti. Civ. Eng.—Lon. Jour. Arts & Sci.

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### *On the Construction of Railways of Continuous Bearing, by* John Reynolds, *A. Inst. C.E.*

The author states the conditions essential for a good railway to be as follows: 1st. That it should be the closest practical approximation to a perfect plane of perfect stability. 2nd. That it should be adapted to prevent or to neutralize the vibrations from the impact of imperfect cylinders rolling on imperfect planes. 3d. That it should possess the greatest durability and the greatest facility of being repaired which are compatible with the above conditions. Mr. Reynolds proposes trough shaped cast iron bearers, having rectangular bearing surfaces, the angular point being downwards. Thus a section of the bearing part of the rail across its length is a right angle, with its vertex downwards. By this peculiar shape the sustaining area is increased, a greater resistance to vertical pressure is consequently obtained, and the lateral stability of the rail is secured. The rails are to be laid in earth, ashes, or broken stone and gravel, and the sustaining surface of the earth may have any requisite density communicated to it by rolling or beating the earth at the sides, so as to give it sufficient density to resist the pressure to which the rail is to be subjected. The mass being composed of materials which will not readily yield or slip away, will be incapable of further condensation by any subsequent pressure not exceeding that to which it had been originally subjected by the beaters or rollers acting at the sides.

The rails which Mr. Reynolds uses are of two kinds; rails wholly of cast iron, cast in one piece, and rails either of wrought or cast iron laid on a sill of wood, the wood being placed in a cast iron bearer of the shape already described. The rails, sills, and bearers in this latter construction, break joint with each other, and are held together by bolts passing through all three. Thus one continuous structure is formed throughout the whole line, and the fracture of three parts in the same place is highly improbable. The vibrations will be neutralized by the sill of wood acting as a partially elastic cushion in receiving the concussion to which the rails are subjected; and this latter mode of construction is considered preferable as admitting of the use of either cast or wrought iron rails.

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February 21, 1837. Bryan Donkin, Esq., in the Chair.

The construction of railways on the principle of continuous bearing, as adopted by Mr. Reynolds, and described in his paper read at the last meeting, was discussed. Some of the rails and bearers cast in a single piece, having been laid on Chatmoss, inquiries were made as to how they had answered. It was stated that they were kept in order at less trouble than the others, and that they showed no tendency to sink. It was intended to use the commonest timber for the sills; the wood having been boiled in tar, and allowed to cool in the tar, becomes so saturated with tar that it will not imbibe moisture. Ibid.

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## Mechanics' Register.

### *Medal Striking.*

We have much pleasure in announcing to the friends of the fine arts that Mr. Pistrucci, chief medallist in the Royal Mint, has discovered a method by which he can stamp a matrix or a punch from a die which has never been touched by an engraver, and shall yet make a medal identically the same with the original model in wax, an operation by which the beauty and perfection of the master's design are at once transferred to any metal, whether gold, silver, or copper, by striking it according to the usual process. It will at once be seen that this is a very different operation from that by which cast medals are manufactured. It is as simple as it is ingenious, and Mr. Pistrucci having no intention of taking out a patent for the discovery, and being anxious to give to the public the full benefit of it, in the different processes of manufacturing plate, jewellery, and all kinds of ornamental work in metal, announces that the whole of the process consists of the following method:—The model being made in any substance, wax, clay, wood, or other fit material, a mould of it is taken in plaster, from which mould, when dried and oiled to harden it, an impression is taken in sand, or other similar substance which may be preferred, and from this again a cast is obtained in iron as thin as possible, that the work may come up sharply, and the iron attain the hardness almost of a steel die hardened. The cast iron impression is then flattened mathematically true on the back, and fixed in a steel die, the hollow of which is turned to the exact size of the cast iron, and is set within the rim or border, hammered as close as possible, so as to form a collar. The metal upon which the impression is to be struck, (to form either the medal itself, or a steel matrix if desired,) is to be fashioned into the shape of a cone in the ordinary way, perfectly flat at the base, heated red hot, and placed at the bottom dish of the press. When the die, fitted as above, having been previously placed at the top dish, and the workmen quite ready to give the blows instantly, three or four, as may be required, a perfect impression of the cast iron will be attained without the least injury to it. Of course it will be necessary, previous to the die being used, for the artist to polish the surface. Mr. Pistrucci's first experiment was successfully performed upon a punch of hard copper, with his model of the medal of Sir Gilbert Blane, being nearly three inches in diameter; and he has no doubt that it will equally succeed on a steel punch, perhaps, too, without its being necessary to heat it. When the process above described shall have been brought to the perfection of which it is capable, there can be no doubt that in the execution of works of this description it will not only be the saving of the labor of months or years in the engraving of dies, and, consequently, of great expense, but the work to be executed will in all points be, in an instant, an exact fac simile of the original conception of the artist, instead of representing, as at present, merely the handiwork of the engraver, copied from such original. It will also dispense with the use of the very expensive machinery, such as the *tour a portrait*, introduced into the mint by Mr. Pistrucci several years ago, which, however apparently correct in its productions, can never give a perfectly true semblance of the original, even to the limited extent to which it is applicable. And we may possibly be led by it to discover the mode by which the artists of antiquity succeeded in producing these beautiful coins, in which the softness and boldness of the fleshy parts have never yet been equalled by any modern engraver in steel. Lond. Mec. Mag.

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## *Water Power.*

The discovery of a new application of water power, which is likely to be attended with most important consequences, has been lately made by a tradesman in this town. Like all truly valuable discoveries, it is distinguished alike for simplicity and efficiency. It consists of a cylinder and a piston similar to those employed in a steam-engine. To the cylinder there are two entrance and two discharge pipes, one of each on either side of the stuffing-box of the piston. The same turn of the cock that admits the water into the one part of the cylinder opens the discharge pipe in the other, and thus a vacuum is formed. To work this, advantage is taken of the pressure of the Shaw's Water, the height of the reservoir of which gives it a force of 60lb. to the inch in the lower parts of the town. A short time ago we witnessed an experiment with a cylinder two inches in diameter worked with a jet of water of somewhat less than a quarter of an inch in diameter, and the piston, although loaded with 1½ cwt., rose and fell sixteen times in the minute. In this case the entrance and discharge pipes were equal in size, and the cylinder was placed in a vertical position. Since then the discoverer has had another model made with the cylinder laid horizontally, and with the discharge pipes nearly three times as large as the entrance ones, and by this means the motion was increased to twenty-six double strokes in the minute.—*Greenock Advertiser.* Min. Jour.

### *Galvanic Telegraph.*

The mode of making instantaneous communications by galvanic power has been put to the most decided test on the London and Birmingham Railway, under the direction of Professor Whetstone and Mr. Stephenson, the Engineer. Four copper wires, acted upon at each end of the line at pleasure, by the agency of very simple galvanic communicators have been laid down on the line of the railroad to the extent of 25 miles. They are enclosed in a strong covering of hemp, and each terminus is attached to a diagram, on which the twenty-four letters of the alphabet are engraved, in relative positions, with which the wires communicate, by the aid of movable keys, and indicate the terms of the communication. The gentlemen to whom we have referred, we believe, are fully satisfied that communications to almost any extent may thus be made instantaneously by the agency of galvanism.—*True Sun.* Lond. Mec. Mag.

### *The Circular Cut.*

Most persons remember their surprise, when children, at the great length of thong supplied from a small piece of leather, by the spiral, or, as it is technically called, "the circular cut." The wonder was worked up into a fable, for Dido was said to have obtained the ground on which Carthage stood, by bargaining for as much as a bull's hide would enclose, and then cutting the hide into thongs, so as to take in a space far larger than the seller expected. This story has gone the round of the world. A friend of ours was informed in Persia, that the English obtained possession of Calcutta by the very same stratagem; the Chinese tell the story of one of their emperors; and the North American Indians believe that this was one of the countless artifices by which the white men deceived their brethren. Athenæum. Ibid.

### *English Railway Stock at Liverpool.*

The prices of some or the best of these stocks were,

| | Par. | July. | August. |
|---|---|---|---|
| Liverpool and Manchester | £100 | £210 | £208 |
| Warrington and Newton | 100 | 179 | 179 |
| London and Birmingham | 85 | 144 10 | 140 |
| Grand Junction | 90 | 180 | 170 |
| Leeds and Manchester | 10 | 14 5 | 13 10 |
| Edinburgh and Glasgow | 2 | 2 7 6 | 2 7 6 |

Mining Journal.

## *Lunar Occultations for April* 1838.

| LUNAR OCCULTATIONS FOR PHILADELPHIA, APRIL 1838. | | | | | Angles reckoned to the right or westward round the circle, as seen in an inverting telescope. ☞ For direct vision add 180° ☜ | |
|---|---|---|---|---|---|---|
| Day. | H'r. | Min. | Star's name. | Mag. | from Moon's North point. | from Moon's Vertex. |
| 6 | 14 | 22 | Im. δ Leonès | ,4, | 80° | 128° |
| 6 | 15 | 22 | Em. | | 213 | 264 |

## *Meteorological Observations for November*, 1837.

| Moon. | Days. | Therm. | | Barometer | | Wind. | | Water fallen in rain. | State of the weather, and Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | Sun rise. | 2 P.M. | Sun rise. | 2 P.M | Direction. | Force. | | |
| | | | | Inches | Inches | | | Inches. | |
| | 1 | 32° | 54° | 29.75 | 29.85 | W. | Moderate. | | Clear—do. |
| | 2 | 36 | 52 | 29.85 | 29.90 | W. | Brisk. | | Clear—do. |
| | 3 | 37 | 54 | 30. 5 | 30. 5 | W. | Moderate. | | Clear—do |
| | 4 | 38 | 60 | 29.95 | 29.90 | W. | do. | | Clear—do. |
| | 5 | 58 | 70 | 29 60 | 29.50 | SW. | Blustering. | .8 | Cloudy—rain. |
| | 6 | 44 | 54 | 29.60 | 29.70 | W. | Moderate. | | Clear—do. |
| ☾ | 7 | 42 | 53 | 29.65 | 29.80 | W. | Brisk. | | Clear—do. |
| | 8 | 36 | 45 | 30.20 | 30 30 | NW. | Moderate. | | Clear—do. |
| | 9 | 31 | 52 | 30.35 | 30.25 | E. | do. | | Partially cloudy—do. do. |
| | 10 | 50 | 63 | 29.95 | 29.95 | SW. | do. | | Cloudy.—partially do. |
| | 11 | 41 | 52 | 30.10 | 29.95 | W.E. | do. | .50 | Cloudy—do —rain in night. |
| | 12 | 55 | 61 | 29.50 | 29.55 | W. | Brisk. | | Cloudy—partially—do. |
| | 13 | 35 | 49 | 29.90 | 29.90 | S. | Moderate. | | Clear—do. |
| ○ | 14 | 32 | 33 | 29.70 | 29.80 | NW.W. | do. | -60 | Snow—snow. |
| | 15 | 26 | 40 | 30.00 | 30. 5 | W. | do. | | Clear—do. |
| | 16 | 32 | 43 | 30.25 | 30.10 | W. | do. | | Cloudy—do. |
| | 17 | 26 | 46 | 30.35 | 30.3 | W. | do. | | Clear—do. |
| | 18 | 36 | 54 | 30.20 | 30.20 | SW. | do. | | Cloudy—partially do. |
| | 19 | 52 | 62 | 30.00 | 30.00 | S. | Blustering. | | Partially cloudy—clear. |
| | 20 | 51 | 67 | 30.10 | 30.05 | S. | Moderate. | | Partially cloudy—clear. |
| ☽ | 21 | 49 | 67 | 29.97 | 29.85 | SW. | do. | | Clear—do. |
| | 22 | 53 | 61 | 29.50 | 29.30 | SSE. | do. | .16 | Cloudy—do—rain. |
| | 23 | 32 | 39 | 29.10 | 29.20 | W. | Brisk. | | Clear—do. |
| | 24 | 31 | 34 | 29.35 | 29.40 | W. | Moderate. | | Cloudy—do—Flurry of snow. |
| | 25 | 25 | 30 | 29 50 | 29.60 | W. | Brisk. | | Clear—lightly cloudy. |
| | 26 | 19 | 33 | 29.87 | 29.95 | W. | Moderate. | | Clear—do. |
| | 27 | 25 | 38 | 30.20 | 30.30 | W. | do. | | Clear—clear. |
| | 28 | 25 | 46 | 30.35 | 30.35 | E.SW. | Calm. | | Clear—lightly cloudy. |
| ⊗ | 29 | 39 | 54 | 30.25 | 30.20 | .SW. | do. | | Fog—lightly cloudy. |
| | 30 | 46 | 59 | 39.25 | 30.10 | W | do. | | Clear—do. |
| | Mean | 37.00 | 50.83 | 29 92 | 29.91 | | | 1.64 | |

| | | Thermometer. | Barometer. |
|---|---|---|---|
| Maximum | height during the month | 70.10 on 5th. | 30.35 on 9th 17th 28th |
| Minimum | do. | 19.00 on 26th. | 29.10 on 23rd. |
| Mean | do. | 44.42 | 29.91 |

# JOURNAL
OF THE
# FRANKLIN INSTITUTE
OF THE
State of Pennsylvania,
AND
# MECHANICS' REGISTER.

MARCH, 1838.

## Practical and Theoretical Mechanics and Chemistry.

### *On Hydraulic and Common Mortars. By General* Treussart, *Inspecteur du Genie. Translated from the French by J. G. Totten, Lt. Col. of Eng. and Brevet Col. United States Army.*

(Continued from p. 94.)

### Article ix.—*On Concrete. Circumstances in which it is advantageous to use it.*

In Belidor's time many foundations were made by stones thrown into the water, putting over at the same time with the stones, mortar susceptible of hardening in water. This mortar took the name of beton; and this manner of founding was called founding *a pierre perdue.* This method was exposed to the great disadvantage of putting too much mortar in some places, and not enough in others; because, when founding in a great depth, it was not possible to see how to distribute the mortar. Now a days, a practice is adopted of breaking up the stones to the size of an egg, and mixing them, above water, with mortar possessing the property of indurating in water, and then lowering the mixture to the spot where it is required. We have seen that the name of hydraulic mortar is given to that which possesses the property of setting in water, and the name of concrete is now confined to the mixture of this mortar with these broken stones. Concrete is therefore nothing else than the masonry made of small materials; and by making, on the surface, this mixture of hydraulic mortar and broken stones, the great advantage of having a homogeneous mass is secured. If the hydraulic mortar be of good quality, the masonry thus formed is very hard: the quality of the concrete depending, principally, on that of the hydraulic mortar.

The method of mixing small stones with hydraulic mortar in order to form concrete in water, appears to have been employed by the Romans. At page 390, Vol. XX, a passage is cited from Vitruvius, in which he says that very solid constructions are made in water, by mixing together puzzolana, lime and stones, (some authors translate it *small stones.*) I do not know whether any Roman works, made in water, of small stones, have been discovered; but some are found out of water, which are evidently the same as our modern concrete. It appears that for a long time the ancient method was abandoned; and that it has been resumed, after perceiving the disadvantages of founding with *pierre perdue.*

If good hydraulic mortar be used, without any admixture of stones, the foundation will be not less solid, but much more costly. The stones are added to the mortar in order to lessen, considerably, the expense. To diminish it still more, a certain quantity of gravel is added, occupying a portion of the interstices between the stones. In countries where stones are not to be had at a reasonable rate, broken bricks may be substituted. And in countries where gravel, only, can be had at a cheap rate—both stones and bricks being dear—the concrete may be formed by mixing this gravel with hydraulic mortar. Wherever masonry and concrete are carried on at the same time, all fragments of stones, bricks, and tiles should be saved: these materials may be usefully employed in the concrete, and with great economy; as they will prevent the necessity of purchasing stones or bricks for the purpose of being broken into small fragments for concrete.

When hydraulic works are founded in shallow water, they are often made of masonry of stone and mortar. For this purpose a dam is built around the spot, the water is pumped out, and the masonry goes on as if upon the surface of the dry ground. But when the depth of water is from six to ten feet, the difficulty of keeping the water out is very great; especially in sandy grounds. Much expense is incurred in pumping out the water; the water often forces itself through the masonry; and the mortar is, thereby, drenched, and sometimes far the greater part washed out, which might occasion formidable accidents in the constructions. Lastly, when the depth of water exceeds ten feet—and it is often necessary to found in much greater depth, as in sixteen, twenty, and twenty-six feet—it then becomes impossible to keep the water free, because of the great quantity that enters through every part, preventing, of course, the execution of the work by such means. In this case the foundation is made either in a caisson, or with concrete. The first consists in making a large chest, perfectly tight in the bottom and sides: the masonry is built therein, and in proportion as the load of masonry sinks the caisson, the buoyancy of this last is increased, by adding buoyant bodies, until the masonry is laid in proper quantity; when the caisson is grounded on the exact spot for the foundation. This means is often expensive on account of the construction of the caisson, which requires much care, and is subject to several inconveniences. To found with concrete, the place on which the work is to be laid is surrounded with sheet piles of suitable strength, driven to a depth a little greater than the level at which the work is to be commenced. The earth within the enclosure is withdrawn to the proper depth, then the concrete is deposited in small quantities and in layers. When the concrete has been brought to the level, or nearly to the level, of the surface of the water, further progress is arrested; and it is left until it is sufficiently hardened to sustain the superstructure. If the hydraulic mortar is of good quality, the masonry may be commenced on this concrete foundation, after ten or twelve days of repose. If, for particular reasons, the foundation was not brought quite to the surface, the water may be drawn off down to the surface of the concrete, in order to lay thereon the first courses of masonry. If the ground is consistent, and the concrete is to be carried only to a small depth, the sheet piling may be dispensed with; it being sufficient to dig out the earth in a proper form and to the proper depth. Lastly, if the ground be bad, and the foundation deep, then, after having driven the sheet piles, and taken out but little earth as a commencement of the excavation, it will be necessary to support the upper part of the sheet piles, to prevent their yielding to the pressure of the earth. An important thing, while the concrete is being sent down, is to prevent, as much as possible, any decided current of water within the enclosure, as this would wash away part of the mortar. Especial care must be taken to make, in the piles, at the level of the surface of the water, an opening, so that the water within shall always be maintained at the same level as the water without; otherwise the difference of level would occasion veins of water through the concrete, which would be very injurious. There might happen to be considerable springs of water in the spot where the foundation is to be made, which would drench the concrete and prevent its setting; in this case the means the most simple of remedying the difficulty, it appears to me, would be the stretching a strong tarred canvass over the springs. There are several modes of transmitting the concrete through the water; one is an inclined trough which conducts it to within a short distance of the bottom; but this means has the disadvantage of making it necessary to divide the concrete into small portions, in order that it may run in the trough, whereby it becomes much washed in the transit. There is the further disadvantage of being obliged, often, to change the place of the trough. Belidor proposed to send down the hydraulic mortar in a box managed with cords, one of which being attached to the bottom, served to upset the box when it had descended low enough. A more convenient mode, though nearly the same, was used at Strasburg; it was as follows: A sort of spoon was made, of strong sheet iron, 20 inches long, and sixteen inches wide; the bottom of the spoon was flat; on the sides and at the back, the iron was turned up square, to the height of six inches, but not in front; the front edge was merely curved upward a little. The spoon was fixed on the sides to an iron handle, having a ring in the middle. This ring was suspended on an iron hook, which was fastened by a socket to a wooden handle; so that the spoon was movable around the point of suspension at the end of the socket, but maintained itself in a horizontal position when filled with concrete. By means of the long wooden handle it was let down to the bottom; when, on pulling a string attached to the back of the spoon, it was upset, the concrete fell out, and the spoon was withdrawn to be again used in the same way. This instrument is very convenient, permitting the distribution of the concrete with facility whenever it may be wanted. It was contrived by Captain Bizos, of the Engineers. When the excavation is large, several workmen are employed, each with a spoon like that described. In No. 4, of the *Memorial de l'Officier du Génie*, will be found the details of the foundation of a baterdeau, with concrete. I will here, however, state succinctly the manner in which the concrete is placed in the situation designed for it, and the precautions necessary to be taken.

When concrete which has been permitted to stiffen somewhat in the air, is deposited in water, it soon softens. A layer is deposited of twelve to sixteen inches in thickness; some time after having softened, it begins to recover consistency. At the end of twelve hours it is to be lightly compressed, and afterward more strongly, by a flat rammer. Whatever precautions may be taken, there is always a portion of the concrete washed out, which forms a layer of soft matter on top of the last stratum. If this soft matter be of some thickness, it will prevent the layers of cement from uniting together; it should therefore be removed, which may be done in several ways. If the foundation be laid in a river, or upon its margin, a couple of labourers are sent out an hour before the general labours begin, who gently sweep the surface of the beton with hair brooms, thus mixing up this soft matter with the water; they then open small gates which have been prepared a little below the surface, in the upper and lower sides of the enclosure. A current is thus established at the surface of the water within the enclosure, and the turbid water passes off—the sweeping being continued till the water becomes quite clear. The concrete which has begun to harden the preceding night, will not at all suffer by this operation, if it be performed gently. If the situation be such that a current cannot be established, then the soft matter is swept into one corner of the enclosure, and is taken out by drags. If the mass of concrete has not much height, the above operation may be dispensed with; but if its height be as much as six or eight feet, it will be proper to resort to the process two or three times during the execution of the work.

Constructors have considerably differed as to the proportions of stone chips and gravel which should be mixed with the hydraulic mortar. I will give the proportions of the materials forming the concrete used at Strasburg.

The first care is to perfect the mortar which is to serve as the basis of the concrete; for on this depends its quality. The hydraulic lime and the cement that are to be employed, will therefore be tested by the processes I have pointed out. If the hydraulic lime be good, a mortar will be made of this lime and sand, as I have explained in page 238, Vol. XX. I stated that the lime should be slaked at night, by measuring, in a bottomless box, of the capacity of about twelve cubic feet, the quick lime, sand, and other matters: that after having slaked the hydraulic lime with about a quarter of its volume of water to reduce it to powder, it should be covered with the sand and the puzzolana. The experiments I have given show that it is advantageous to let the hydraulic lime repose during twelve hours at least, after being slaked to powder and covered with sand, but that it should not be left in this state more than from ten to fifteen days, before being made into mortar.

If the hydraulic mortar is to be made of fat lime and hydraulic cement, we have seen that there will be an advantage in slaking the fat lime one or two months before hand, with about one third of its volume of water. When the lime has been slaked in this manner, it will be put in a covered place, and at the expiration of the time mentioned, it will be measured either in powder or paste, and mixed with the quantities of sand and hydraulic cement that shall have been found necessary to compose the mortar. If pressed for time, the mortar may be made with lime fresh from the kiln—and it may even be made with lime that has been for a long time melted into cream—but with less advantage.

I suppose then, that hydraulic lime is to be used, and that it has been slaked towards evening, with a quarter of its volume of water, as directed above; the next morning, or several days after, as the case may be, one of the heaps is passed, dry, a couple of times under the Rab; the quantity of water is then added that is necessary to bring it, with thorough mixing, to the ordinary consistence; and if there be no pressing need, it is made into a heap till evening. It is then worked anew with a little more water, and again brought to the ordinary consistence: it is then spread out in an even layer of four to six inches thick, and is covered as uniformly as possible with the stone chips and gravel; the whole will then be several times turned with the shovel until the stones, gravel, and mortar are well mixed together. The concrete being thus made, will be poured into a heap, and left until it has acquired a degree of stiffness permitting it to be broken up in large pieces.* It is in this state when it is put in the spoon to be lowered down to the bottom, as described above. We have seen, by the experiments of table No. XXVIII, that hydraulic mortars gain sensibly when they are left until they have somewhat stiffened. The time required to come to this state depends on the season: if it be very hot weather, the concrete acquires the due consistence in about twelve hours; generally twenty-four hours are required, and sometimes thirty-six hours.

If the concrete be made of fat lime, sand and hydraulic cement—after having slaked the lime to powder and left it at rest in the air for some time, the mortar will be made as with hydraulic lime, and it will be treated in the same way, to form concrete. We see then, that there is no difference in the manner of using these two kinds of lime, except that with hydraulic lime, to obtain the best results, it is necessary to make the mortar soon after the lime is brought from the kiln; while with fat lime, it is best that the lime be left a month or two in the air after having been slaked.

The quantity of stone-chips and gravel to be mixed with the mortar, has varied much according to different constructors. As I have before said, the object of these matters is to lessen the expense; and such a quantity should be put in as that all the fragments shall be tied together by an adequate quantity of mortar. The first concretes made at Strasburg were composed as follows:

| | |
|---|---|
| Hydraulic lime measured before being slaked | 0.75 |
| Sand | 1.50 |
| Gravel | 0.50 |
| Stone-chips | 1.00 |

This concrete was designed for foundations of revetments and other works of that kind.

To make floors of Locks and other hydraulic works, the concrete was composed thus:

| | | |
|---|---|---|
| Hydraulic lime measured before being slaked | 0.75 | The resulting bulk of beton was 300 |
| Sand | 0.75 | |
| Trass, or hydraulic cement | 0.75 | |
| Gravel | 0.50 | |
| Stone-chips | 1.00 | |
| | 3.75 | |

Experience afterwards taught us that we could make the mortars with one part of Obernai lime measured as quick lime, and two parts and a half of sand, without making it too meagre. As to the other materials, several cubes of concrete of about twenty inches length of side, and containing various proportions of stone-chips and gravel, were made, and put under water in a ditch; and at the end of a year they were broken, with iron masses, to determine the quantity of stone-chips and gravel that might be added without disadvantage. After the experience of these trials, the mortar was made of one part of Obernai quick lime, and two parts and a half

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*In the last *Devis Instructife du Genie*, it is said, page 63, that after having mixed the mortar of the concrete with the stone chips, all will be made into a heap to be used immediately; and in note 53, referring thereto, it is said that this is the process that was followed at Strasburg. This is a mistake; at Strasburg the concrete was always left at rest in the air until it had acquired enough consistence to be attacked with the pick, and it was never used immediately after being made. Au.

of sand only, or of sand mixed with hydraulic cement in various proportions, according to the importance of the work. Thus ordinary mortar, whether for the concrete of coarse *(gros)* works, or for gross masonry, was composed of 0.30 of Obernai quick lime and 0.75 of sand. For works more important, the mortar was composed of 0.30 of Obernai quick lime, 0.30 of hydraulic cement, and 0.45 of sand. Sometimes it was made of 0.30 of Obernai quick lime, 0.20 of hydraulic cement, and 0.55 of sand. There was almost always added to this mortar from 0.60 to 0.75 of stone-chips and gravel—nearly in the proportion stated above; that is to say 0.25 of gravel and 0.50 of stone-chips; and it was found that the mortar could bear this quantity without disadvantage. The heaps of beton were thus made up of about 1.80 of materials, which, on being mixed, sustained a diminution of from $\frac{1}{6}$ to $\frac{1}{5}$, according to the proportions used.*

Each heap of concrete, containing about 64 cubic feet of materials, requires four men to make the mortar, mix therewith the stone fragments, and deposite the concrete in the water. If the work requires ten heaps to be made in a day, forty men will be necessary. There will also be required, for such an operation, two intelligent men to slake the lime, and proportion the materials; two workmen, also, will be employed in breaking the stone; and a carpenter will be needed to mend tools, repair scaffoldings, &c., and, lastly, two or three workmen will be wanted for unforeseen calls. There would be great economy in making the mortar by means of the machine described in page 239, vol. xx.

Mr. Vicat thinks that concrete should not be left to take any consistency in the air. According to this Engineer, it should be deposited while it is yet ductile. In the observations made by him upon the pamphlet which I published in 1824, he says: "Mr. Treussart has occupied himself with the management and manipulation of concrete: he is of opinion that concrete which has acquired a degree of stiffness in the air becomes harder in water than when it is immersed of the ordinary consistence, that is to say, soft. That is true; but only when the cohesion of the concrete is preserved, after the immersion, by the aid of some envelope; and this Engineer was wrong in practising the defective method indicated by Belidor, namely, leaving the concrete at rest in the air until it had required such hardness as to be attacked only with the pick, and then to place it in water, where it softened, and loses, afterward, all consistence. I have found that, after eight months, the absolute hardness of a concrete made of puzzolana, immersed according to Belidor's method, was, on an average, to that of the same concrete immersed in a stiff though ductile state, as 15 is to 100."

It would not be difficult to bring forward a great number of facts, completely overturning what is here advanced by Mr. Vicat. In 1818 the baterdeau of Fort Mutin at Strasburg was constructed on a mass of concrete of more than 260 cubic yards. In making the concrete the process given above was followed; and the process of Belidor was pursued in depositing it. Eight days, only, after it had been deposited, the masonry was begun, and was pushed with much activity to completion. This baterdeau

---

* The above proportions expressed in other terms, are,

| | | | |
|---|---|---|---|
| Hydraulic lime as before | 0.60 | 0.60 | 0.60 |
| Sand | 1.50 | 0.90 | 1.10 |
| Hydraulic cement | | 0.60 | 0.40 |
| Stone-chips | 1.00 | 1.00 | 1.00 |
| Gravel | 0.50 | 0.50 | 0.50 |

Tr.

sustained, only six months after it was commenced, one of the highest floods of the River Ill, without the occurrence of any kind of accident.

If the concrete became soft, and lost all consistency, as Mr. Vicat supposes, how was it possible to construct the masonry thereon after only eight days? The concrete would have yielded to the weight of the baterdeau if it had not been of strong consistency; and cracks would have appeared at the junction of the old masonry. The baterdeau would have been carried off by the first flood of the Ill, if the concrete had not been very hard. At a later day, we successively built upon foundations of concrete a scouring sluice with five passages, in the great ditch of the Town: then an escape sluice and several other works, and lastly a *canal à poutrelle* in the great ditch, to lead the water to a mill—all the bottom of this canal being of concrete. All these concretes set in a short time, to great hardness; and during the same season, the masonry was constructed on these foundations, without any accident resulting.

Mr. Vicat says that the absolute hardness of a concrete immersed in Belidor's mode is, on the average, compared with that immersed while firm and ductile, as 15 to 100. We have seen by the experiments of table No. XXVIII. that mortar which had been reworked, sometime after it was made, and which had been at rest afterward, before plunging it in water, gave a better result than when immediately immersed. Mr. Vicat admits it to be true, when the cohesion is preserved by the aid of an envelope. I can conceive that this Engineer might have obtained the result he announces, if he destroyed the cohesion of the concrete that he submerged in Belidor's mode; that is to say, if he reduced it to small fragments; but that was not the way we operated at Strasburg. When the heaps had taken some degree of hardness, they were not broken up into small pieces, but they were broken by the pick into large pieces which were transmitted down through the water by means of the spoon above described. On breaking up the heap of concrete into large pieces, there remained some small fragments, though not in considerable quantity, when the concrete had adequately stiffened. These were made anew, into paste with water, and added to the heap of concrete then being made; or transmitted by the spoon and deposited on the concrete under water. I do not therefore think that Belidor's process has any disadvantage: and the considerable works carried on in this way at Strasburg, afforded very good results. The concrete hardened very promptly—Mr. Vicat's operation to the contrary notwithstanding. I do not say there would be great disadvantage in immersing the substance as soon as made; but I believe it would be more exposed to be washed. The process of Belidor was followed at Strasburg, because the experiments which have been cited had taught me that mortars which were destined to be put in water, were better when worked up of the ordinary consistence than when worked up stiff, and that there was a sensible saving in the manipulation. But, in this soft state, the mortar would have been much washed, if put at once into water; for which reason it was left to harden somewhat, according to the advice of Belidor.

It often happens that the floors of sluices, and foundations of hydraulic works, may be built, without being troubled with water. In such cases these floors and these foundations are ordinarily built of stone, resting on grillages: but wood does not unite with masonry, and the mortar often unites badly with the stones: whenever these constructions have to support a considerable pressure of water, leaks will, therefore, be the consequence. In such instances, where floors of locks and foundations of dams can be constructed without the presence of water, I think it would be preferable to make them of concrete: the expense of grillages would be saved, and they almost always cause leaks. It would be necessary, after the concrete is laid, to cover it with a few inches of water, or with a layer of moist earth: because, in general, hydraulic mortars take a stronger consistence under water, or in humid ground, than when they remain exposed to the air, and especially during summer.

If we notice the retained waters at mills and locks, we see that when the walls are constructed of large cut stones, the water often escapes through the joints, carrying away the mortar, causing a considerable loss of water by leakage, and finally involving the destruction of the works. I am pursuaded that there would often be economy, and always great advantage, in making the side walls of Locks of concrete, instead of stones or bricks, or perhaps the concrete might be restricted to those parts where leaks are most apt to appear.

The use of concrete is very advantageous in the foundations of constructions in water, because it avoids the necessity of drawing off the water, always very expensive, and which has the great disadvantage, by the differences of pressure which result, of giving rise to veins which dilute or wash away the mortar. We have not as yet derived all the advantages that concrete will afford. I am pursuaded that ere long, when it shall be required to construct the piers of a bridge; or a revetment, in a river of from seven feet to twenty feet depth, the method of caissons will be abandoned. The following process, it appears to me, might be followed with advantage.

After having surrounded the space in which the foundation is to be laid with a row of jointed piles in contact, or a row of strong sheet piling; it will be easy to drag out the bottom to the depth of about seven feet, and to fill the excavation with concrete up to the level of the bottom of the river, or a little below, if it be supposed that the works will cause the bottom of the river to be somewhat lowered. When the concrete has been placed, and while it is yet somewhat soft, a second range of sheet piling should be driven into the concrete itself, parallel to and three and a half to five feet distant from the first row. These sheet piles should be driven only about eight inches into the concrete. It will be easy to connect the second row of sheet piles firmly to the first row by means of ties and braces. When this is done, the concrete will be left to take a suitable hardness, and then the space between the rows of piles will be filled with good puddling earth. There will thus be obtained a coffer dam reposing upon concrete; and all the water may be withdrawn from within the inner piling, without leaving any leaks, provided the concrete has hardened sufficiently to resist the pressure of water. It will therefore be easy to build with masonry, upon all that part of the concrete which is within the enclosure.

If it should happen, in consequence of the depth of water, that there was reason to fear the whole bottom of concrete might be raised; this might be easily guarded against by placing wooden trestles on the concrete—these trestles supporting timbers bearing a platform and the necessary load of stones: when the masonry—begun between the trestles, should be sufficiently advanced, this scaffolding with its load would be removed. The masonry being raised above the surface of the water, the inner row of sheet piles may be easily removed and also the earth of the dam. As to the exterior row of piles, or sheet piles; if they have been driven in as deep as six or eight feet, it would be somewhat difficult to remove them. To lessen this difficulty, it would be well, before depositing the concrete, to stretch some canvass along the lower part of the inside of this outer row of piles, to prevent the concrete from introducing itself into the joints; or lastly, this outer row may be sawed off level with the bottom.

We see that by this method we are obliged to make the foundation rather larger than would be otherwise necessary; but this is no disadvantage to the work as it will increase the stability. If the nature of the ground be such as to require piles under the foundation, they will be driven as in the ordinary method. There will be the advantage of not being obliged to drive them very equally, nor to saw them off at the same level exactly, as is necessary when founding with a caisson. In founding with concrete, it will suffice to drive the piles to the same level within a few inches. When the concrete is sent down, it will spread itself at the same time, on the ground, and around the heads of the piles, to which it will exactly mould itself. If the mass of concrete is from five to seven feet deep, it will form, as it were, an artificial rock resting on piles, and capable of sustaining an immense load of masonry without the slightest injury.

I was under the necessity of studying the project of which I have given above the principal dispositions merely, because we had in view, early in 1825, a bridge on piers of masonry across the Ill, which river is from six to ten feet deep; and, being subject to floods, would have offered great difficulties. I am well convinced that the method I have summarily indicated would have had great advantages over the various modes in use, including the method with caissons; which cost a good deal in the first place, and demand great care in cutting off the piles exactly at a level, and in properly grounding the caisson thereon. Besides it is almost always requisite to surround the foot of the caisson with loose stones, which considerably restrict the passage for the water between the piers, thereby augmenting its velocity, and consequently increasing its wearing action on the bottom. By the method I have suggested, all these inconveniences are avoided: and it is equally applicable to sluices, dry docks, and all other hydraulic structures that are to be made in depths exceeding 20 feet, and where it would become very difficult and expensive to get a foundation by making coffer dams and pumping out the water.

When it is required to build in stagnant water, or where there is a gentle current only, and the materials for a very good concrete are at hand, the whole foundation may then be made of concrete to within a short distance of low water level. It will not be necessary, in this case, to give so great a breadth to the foundation, as in the preceding case; the inner row of sheet piles might be smaller; and they might be separated from the outer row only by the breadth of an ordinary offset in the foundations. No puddling would be needed; all the space within the inner row would be filled with concrete up to low water level nearly, where the stone masonry would be begun. The pier being finished, the two rows of sheet piles would be removed as in the preceding case. When the pier is to be built, thus, of concrete up to low water, the current must be feeble, and the materials whereof to compose the concrete, very good. In cases where one of these conditions is wanting, it will therefore be most safe to use the first method, which brings the concrete no higher than the bed of the river, finishing the rest with masonry, for I doubt if a concrete can be made which will resist the continued action of a current of water, as effectually as masonry made of good stone.

### ARTICLE X.—*Summary of the First Section.*

From the facts presented in the foregoing articles, may be deduced the following conclusions.

There are two modes of making hydraulic mortar; first, by making it of lime that is naturally or artificially hydraulic, and of sand; and secondly, by making a mixture of common lime and puzzolana, or of some analagous substance.

In countries where there are good natural hydraulic limes, it is very advantageous to employ them; and in such cases no use should be made of fat lime. In gross masonry, they may be used with sand alone; but when it is required to construct the foundations of sluices, roofs of arches, and other similar works, it is advantageous to add to the mortar, a little hydraulic cement.

In a country where there is no hydraulic lime, in lieu of making it by calcining lime with a little clay, it is more advantageous, and more economical, to make hydraulic mortar by mixing, directly, fat lime with hydraulic cement and sand. The advantage is the greater in countries where there is no chalk, and where it would be necessary to submit the lime stone designed to be made hydraulic, to two successive burnings—burning it the second time with a small quantity of clay.

Fat lime becomes hydraulic by being burned to the proper degree with a little crude clay; this result is not obtained if the clay has been previously calcined. Fat lime also gives a good hydraulic mortar, when it is united in the moist way with a mixture of equal parts of puzzolana and sand, and when the proportion of these substances is at least double that of the lime.

Silex, when it is very finely divided and disseminated in lime stone, produces good hydraulic lime, as is proved by the Senonches lime: when fat lime and finely divided silex are burned together, a hydraulic result, though feeble, is obtained. Iron and the oxide of manganese communicate to lime no hydraulic property: iron in the state of brown or red oxide, prevents the lime from heating much in process of slaking. It does not appear that alumine or magnesia, cause lime to become hydraulic; but when these substances are mixed with silex, good results are obtained. The best process for converting fat lime into hydraulic lime, is to burn it with a small quantity of crude clay; the proportion of $\frac{1}{5}$th of clay, seems the most suitable; and it appears that the best clay is that which contains as much silex as alumine.

The quality of hydraulic lime is improved by mixing with the clay that is to be burned with the lime, a small quantity of water containing soda; a better result is obtained with potash; but this means would be too embarrassing, and would occasion an excess of expense which might not be in proportion to the advantage, were the operations on a large scale.

Hydraulic lime bears less sand than is commonly thought; there are few of these limes which can be mixed mith more than $2\frac{1}{2}$ parts of sand, without sensibly diminishing the resistance of the mortars. Fat lime may take a greater quantity of mixed sand and puzzolana to form hydraulic mortar.

Puzzolanas, or hydraulic cements, which are energetic, apply equally to hydraulic lime and fat lime. In mixing hydraulic lime, or fat lime, with sand and puzzolana, or other analagous substance, in equal parts, a better result is often obtained than by mixing these limes with puzzolana alone.

When very hydraulic lime is used, the addition of sand permits a sensible diminution of the quantity of puzzolana, natural or artificial, required to obtain a prompt induration and great resistance. With fat lime there always results a very good mortar, on mixing it, in equal parts, with sand and natural or artificial puzzolana; and if it sometimes happens that a mortar a little superior is obtained with lime and this last substance, without the sand, the advantage is not so great as to compensate for the greater economy of using sand also.

Hydraulic limes are difficult to burn to the proper degree. When they are not sufficiently burned, they slake badly; and the resulting mortar has not all the tenacity it ought to have.* A degree of heat a little greater than it should be, causes, with these limes, a beginning of vitrification; they then slake slowly; the mortar they form loses its force, it swells after having been used, and may occasion considerable injury to the works. Hydraulic limes should be used soon after leaving the kiln; they should not be slaked with much water, like fat limes, nor be left in a state of cream, like them, because, in a very short time they would become very hard, and it would be impossible to make use of them. Whether slaked with a small quantity of water to reduce them to dry powder, or left to slake in the air, they, in general, very soon lose a part of their hydraulic properties, and finally pass to the state of common limes. It is likely that this effect is due to the absorption of oxygen by the hydrate. It would appear that hydraulic limes containing the oxide of maganese preserve their energy better when they have been left to slake in the air than when they have been slaked to powder by water. Notwithstanding the precautions that hydraulic limes demand, it is important to employ them whenever natural limes of this sort, of good quality, can be obtained, because they supply a very good mortar at a cheap rate. We should carefully study the exact point of burning, and should satisfy ourselves, as to whether or not they soon lose their hydraulic property, on exposure to the air, when slaked to dry powder, or when air slaked; without these precautions, we may expose important works to failure, by making very bad mortar out of very good lime. Common lime has not, like hydraulic lime, the inconvenience of losing a part of its qualities by a degree of heat a little greater than that which is most suitable. A very violent fire is required to produce this result. Whether slaked with much water so as to be made into a fluid paste and run into vats, or with a little, only, so as to be reduced to dry powder; or if spontaneously slaked in the air; or if used immediately as it comes from the kiln, a good hydraulic mortar is always obtained by mixing fat lime, in equal parts, with sand and natural or artificial puzzolana. By air slaking the result is the least good. It appears that by slaking in the air, the lime absorbs a considerable quantity of carbonic acid; and the mortar which results is filled with white points, which are particles of carbonate of lime, that cannot be made to disappear, whatever pains may be taken in the mixing process.

The best mode of slaking hydraulic lime is to sprinkle it, as it comes from the kiln, with about one fourth of its bulk of water. A measure containing about one third of a cubic metre (a cube of about three feet three inches on each side) permits the mixture of the materials that are to compose the mortar, to be easily made. Before sprinkling the lime, it is to be surrounded with the mortars that are to be mixed with it, and when it is slaked and gives out no more vapours, it is to be covered with these mortars. The lime is left in this state for twelve hours at least, and for eight or ten days at most. The quantity of water necessary to bring the mortar to the ordinary consistence is afterward added. Care must be taken to make the mortar no faster than it is needed. The heap of lime surrounded by the sand and other materials should be covered from the rain.

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*This is understood as applying only to hydraulic lime stones which have been burned sufficiently to be employed as lime; as to those which have been burned but very little, to be employed as cements, according to the process of Mr. Lacordaire, I have no experience that will enable me to pronounce as to the tenacity of the mortars they afford. Au.

With common lime the process will be a little difficult; being slaked as it comes from the kiln, with one-third of its volume of water, the lime, in a state of powder, should be put under cover, and left in this state for one or two months. At the end of this period it should be measured in paste and mixed with the sand and cement in due proportion, adding the quantity of water necessary to bring it to the consistence of ordinary mortar. This process is the one which gives the best results; but if this be inconvenient, the lime may be used as it comes from the kiln, or after it has been lying wet in vats for any length of time.

A great deal of trituration is useless, either with hydraulic or with common limes. It is enough if the mortar be homogeneous, which is the case when a heap of about thirty-five cubic feet has been passed under the Rab five or six times by four men. Mortar made of ordinary consistence, and even rather thin, is easier to mix thoroughly, and gives better results than when it has been mixed in a stiff state. If it becomes a little dry before being used, there is no objection to working it anew, with the addition of a little water. It might be left from night till morning, to be then passed twice under the rab: the mortar acquires more consistence by moistening it a little. It might be remixed in this way during a couple of days without losing its force.

In mortars made of hydraulic lime, the sand appears to be in a passive state; in hydraulic mortars made with fat lime, the puzzolana or other analogous substance, enters into combination with the lime; and it appears to be that combination which gives to the mortar the property of hardening in water. Fine sand is preferable to coarse for hydraulic mortars; that which is earthy diminishes the force of the mortar considerably.

When one part of quick hydraulic lime is mixed with two parts of sand, the resulting mortar is diminished about one fifth; the diminution is only about one sixth if the mixture be one part lime and two and a half sand.

All clays calcined to the proper degree, and reduced to powder, are susceptible of giving factitious puzzolanas—better or worse, according to the composition. The clays most proper to make good puzzolanas are those which are greasy to the touch—such as are commonly used for making Dutch ware, stone ware, earthen ware and tobacco pipes. Clays which contain one fourth of alumine are greasy to the touch: those which contain from one third to one half, give very good results. The substance of which it is most important to observe the presence in clays, is lime. If this substance exists in the clay in the proportion of one tenth, or more, and the clay be exposed to too great a heat, a cement will be obtained which will not possess the property of causing lime to harden in water; but if it be moderately burned, a good result will be secured. The more lime there is in the clay, the less it should be burned.* When no lime is present, it is generally necessary to burn the clay as much as a well burned brick; some clays demand a degree of heat a little greater, according to their proportions of alumine and silex. Even when the clay contains no lime, it should not be too much burned; otherwise it will lose part of its hydraulic property. When it contains up to one-tenth of lime, it requires a less degree of heat than is needed to produce a well burned brick. When it contains more than one tenth, the heat required to burn tiles is sufficient. The clay is supposed to be moulded before burning, into bricks of ordinary dimensions.

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* When I speak of lime contained in the clay, it is meant that the lime is in the state of carbonate. Au.

When the clays contain only four or five per cent. of lime, some having been properly burned, seem to be benefitted thereby, and others, not; which appears to depend on the proportions in which the silex and alumine exist in the clay. Lime cannot therefore be considered as augmenting, in a sensible degree, the energy of puzzolana; but it has the advantage of bringing the clays more promptly to the proper state of calcination, and making them easier to pulverize: in these respects, therefore, the presence of a little lime tends to economy. Clays which contain about one-third of alumine, and four or five per cent. of lime, appear to be most favourable to the production of puzzolana, provided they be burned to a degree a little below that required to give a well burned brick.

Cement suitable for making a good mortar for heavy masonry, may be made out of ordinary bricks. The dust of tiles, has no advantage over that of bricks, as a cement. The important point is to know the true degree of calcination which the clay requires. Bricks should not be taken indiscriminately from the kiln, but those should be selected which have been found on trial to afford the best hydraulic cement.

Iron gives no energy to Puzzolana; it even seems to be more injurious than beneficial: for ochreous earths did not give good results while with clays entirely without iron, very good were obtained.

Carbonate of magnesia, which is often mixed with clays in small proportion, has no influence when the burning is carried only to the degree proper to yield good hydraulic cements.

Soda does not appear to have a sensible influence in improving hydraulic cements or artificial puzzolanas, but potash has a marked effect. When the clays which it is desired to convert into hydraulic cement, have imbibed a solution of potash, standing at 5° of the *pese acid*, equal in bulk to one-fourth of that of the clay, the cement is sensibly increased in energy; but the advantage to be derived does not appear to me to be so great as to recommend this means in practice. With such clays as I have designated, artificial puzzolanas are obtained, which are in no degree inferior to the natural productions; and by these means, proportioning the cement properly, mortars may be obtained of very great hardness.

Nitrous clays appear to be good for the purpose of being transformed into hydraulic cements: clays containing a little saltpetre (Nitrate of potash) should not, therefore, be rejected.

When the clays that are to be calcined have had a little of the solution of soda, potash, or saltpetre, at 5° of the *pese acid*, added to them, they do not easily lose their hydraulic property by too high a degree of calcination.* This mode would be embarrassing and occasion some expense; but common salt (muriate of soda) might be substituted, and would be but little expensive or troublesome. It appears probable that a like result would be obtained with sea water: because we have seen, page 7, that the Dutch make artificial trass of clay which they draw from the bottom of the sea; and which they sell as natural trass.

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* This is the effect, when the clays contain no lime; but I do not know whether it would be the same, if lime were present. Au.

When the clays to be transformed are calcined with a current of atmospheric air, the mortars harden in the water much more promptly than when the clays are burned out of a current of air. I cannot assert that the resistance of such mortars is much greater, though it appears to me to be probable. As it is important to obtain, in many circumstances, mortars which harden promptly in the water: the clays on these occasions should be calcined in a current of air, in such furnaces as I have described.

Ashes, and the scoria of forges, belong to the class of artificial puzzolanas: there are some which give very good, and others which give very bad results.

Basalt, when calcined to a proper degree, affords good artificial puzzolanas.

Amongst mortars composed of hydraulic lime and sand, those which harden most promptly in water do not always give the greatest resistance: but those do, generally, which are composed of fat lime and puzzolana either natural or artificial. The most certain means of knowing whether hydraulic lime is of good quality, is to reduce it to paste with water, and to plunge it in this state, into water, to see if it hardens speedily: or, otherwise, to mix one part of the lime in paste, with two of sand. To learn the quality of hydraulic cements, or natural puzzolanas, it is proper to make a little mortar, using two parts of cement, and one of fat lime measured in paste, and place it under water.

All hydraulic mortars harden quicker in summer than in winter. If the mortar, made for trial in summer, is composed of hydraulic lime and sand, or if it be composed of hydraulic lime alone, a very good result will be certain, if at the end of eight or ten days the hardening be such that no impression can be made on the essay by pressing strongly with the finger. If this result is obtained only after the lapse of fifteen or twenty days, it is a proof that the lime is only moderately hydraulic.

With mortar made of hydraulic cement and fat lime, a similar induration should be obtained in from three to five days, if the cement be of the first quality, and if it has been calcined in a current of air. Should the hardening take place only at the end of twelve or fifteen days, with cement calcined in a current of air, it may still be employed with advantage. But if the cement has not been calcined with a free current, instead of hardening in from three to five days, it will require from twelve to fifteen, and still give a very good resistance. It may be estimated that, in winter, the induration will demand nearly twice as much time as in summer, without any diminution of the strength of the mortar.

*Arenes* are clays which have been subjected to the action of fire: they are therefore true natural puzzolanas. It appears that France contains this substance in many places; and it will be found in many more, as researches shall be multiplied. It is with arenes as with natural puzzolanas and trass: all have not, by any means, the same energy: but those which are feeble may be advantageously employed in mortars to be exposed to the air, while those which have more energy may replace hydraulic cements in constructions under water, in the case of ordinary works, and where no circumstances demand a prompt induration.

The use of energetic arenes affords good mortar for masonry in water and in air, at a very cheap rate.

Concrete is nothing else than masonry made of hydraulic mortar and small stones. The use of concrete is of great advantage in founding under water at depths which occasion great expense if pumped dry. Foundations in concrete require little or no pumping: they are capable of supporting the heaviest loads.

The goodness of the concrete depends on the quantity of the hydraulic mortar. It appears that the ancients sometimes constructed with this substance: its use since has been much neglected. All the advantages possible, have not yet been derived from this mode of construction; its advantages will be better appreciated when its use shall be more extended; and when the manner of perfecting hydraulic mortars shall be better understood.

## SECTION SECOND.—On Mortars in the Air.

### Article xi.—*Of Mortars made of Lime, Sand and Puzzolana.*

If it is of great consequence, in making mortars that are always to remain under water, to be able to make them of good quality; it is of no less consequence to know how to prepare those which are to remain exposed to the air, in such a way that the masonry shall be lasting. People have been struck with the solidity of the remains of Roman masonry, while masonry which we ourselves have erected has often been of very limited duration. All have concurred in attributing the difference to the superiority of Roman mortars. To explain this superiority, it has been supposed that the Romans were possessed of a peculiar manner of slaking lime. Mr. Lafaye published in 1777, a method of slaking, which consisted, as described in our first section, in plunging the lime in the water for a few seconds—the lime being placed in baskets, and then to allow it to slake in the air. He gave this process as a secret recovered from the Romans; and he pretended that by this process as good mortar was obtained as theirs. This made much noise at the time; but it was soon ascertained that although there was some advantage in this mode of slaking lime, it was far from giving the mortars the superior quality the author claimed. Afterward, Mr. Loriot announced that mortar like that of the Romans might be obtained by mixing a certain quantity of powdered quick lime with lime slaked and reduced to paste in the common mode; but experience did not confirm this method of M. Loriot.

Others, to explain the goodness of Roman mortars, have attributed it to the time that has elapsed since the works were executed, whence has come the saying that "mortar is still new that is not one hundred years old," (*le mortar que n'a pas cent ans est encore un enfant.*) But then, it is asked, how comes it that so much masonry perishes before it is an hundred years old, while, in the same climate, some is found which has passed through near twenty centuries without repairs, and far the greater part is still standing? Those who pretend that a great lapse of time is necessary to the induration of mortars, think that the lime absorbs carbonic acid (although situated in the heart of the masonry) and thus passes to the state of carbonate; but several facts contradict this opinion: for there are certain limes which afford very good mortar in a very short time, while others never indurate, as is often seen in demolitions. On the other hand we have seen, in the first section, that according to the analysis of several ancient mortars, many were found which had very great hardness, and which nevertheless contained only a small quantity of carbonic acid; and we know that the lime used in building is never wholly deprived of it. We cannot admit, then, that carbonic acid penetrates far into the interior of masonry; and it is proved, by multiplied observations, that moisture remains during a very long time in the interior of certain walls. Dr. John reports, on this subject, that about ten years ago, they demolished the piers of the Tower of St. Peter's, at Berlin; this tower had been built eighty years, and the pillars were twenty seven feet thick; the mortar on the outside was dry and hard, but that in the middle was as fresh as if it had been lately placed there. I can state that in 1822, that the lower part of a bastion at Strasburg, being under repair, the mortar was found to be as fresh as if just laid, and nevertheless, this bastion was erected in 1666; the revetment was only about seven feet thick, but the moisture of the earth resting against it, prevented the lower part from drying. Similar facts are observed in constructions still more ancient. It results from what has been advanced, that the good quality of the mortars of several ancient structures is not due to the manner of slaking the lime, as Mr. Lafaye supposed, nor to the process of making mortar supposed by Mr. Loriot, nor to the time that has elapsed since they were built. The experiments which follow will confirm this remark; which is in accordance also with general opinion at the present day. The great number of hydraulic works which were to be repaired or rebuilt at Strasburg, induced me to direct my first researches to the object of obtaining good mortars for the water; and it was only when these were well advanced that I began to study mortars for the air. I quitted the place before finishing my experiments. The experiments that I made, though few, appear to me, however, to throw some light on the theory of mortars in the air, and to explain in a satisfactory manner, whence was derived the good quality of the mortars found in many ancient works. It will be useful I think to report them.

It is the opinion of a great many constructors that when common, or fat lime is to be used, it is necessary to have it lie wet in vats or pits for a long time: it is asserted, that the older it is the better it is. The experiments of the following table have for object to verify this important point.

### Table No. XXX.

| No. of the mortar. | Composition of the mortars, | | | Weights supported before breaking. |
|---|---|---|---|---|
| 1 | Fat lime which had been lying a long time wet—measured in paste . . . . . | 1 | 3 | 0 |
| | Sand . . . . . . | 2 | | |
| 2 | Same lime . . . . . | 1 | 3¼ | 0 |
| | Sand . . . . . | 2¼ | | |
| 3 | Same lime . . . . . | 1 | 3½ | 0 |
| | Sand . . . . . . | 2½ | | |
| 4 | Same lime . . . . . | 1 | 3¾ | 0 |
| | Sand . . . . . . | 2¾ | | |
| 5 | Same lime . . . . . | 1 | 4 | 0 |
| | Sand . . . , . . . | 3 | | |

*Observations on the Experiments of Table* No. XXX.

To make these experiments, I took fat lime which had been slaked and lying wet in a pit for five years—a portion of the same having been used in the construction of the theatre of Strasburg. The mortars were all made in the same manner, and broken in the same way as the hydraulic mortars; they were left in the air in a cellar for one year before cutting them down to their ultimate dimensions and submitting them to the test: the proportions of sand varied from two up to three parts of sand for one of lime measured in paste. The resulting mortars had no consistency, and crumbled between the fingers with the greatest ease. I confess I was much surprised at the result, for the sand which I used was the same as that used in the mortars of the first section; and, as I have said, was a granitic sand very slightly earthy. I made another experiment with the same lime, and the same sand washed to free it of the small quantity of earth which it contained, but I obtained no better result. I also repeated this essay with another sand, also washed, varying the quantity of water used in making the mortar, but always with results similar to those of the above table, that is to say, mortars without any consistency.

These bad results cannot be attributed to the quality of the lime, for it has been shown by the analysis in page 378, Vol. XX, to be the product of a calcarious carbonate containing only a very small quantity of iron: this is the lime that has been used for a long time both for the public and private edifices of Strasburg. The theatre, as I have observed, was built of this lime: this beautiful structure does not promise, therefore, to be of long duration.

At the same time that I made the experiments of the preceding table with lime and sand, I made corresponding ones with the same lime and trass, and also with lime, sand and trass. The following table gives the results.

Table No. XXXI.

| No. of the mortar. | Composition of the mortars. | | | Weights supported before breaking. | Weights supported before breaking. |
|---|---|---|---|---|---|
| | | | | lbs. | lbs. |
| 1 | Fat lime which had been lying a long time wet, measured in paste | 1 | 3 | 242 | 440 |
| | Trass | 2 | | | |
| 2 | Same lime | 1 | 3¼ | 264 | 484 |
| | Trass | 2¼ | | | |
| 3 | Same lime | 1 | 3½ | 286 | 517 |
| | Trass | 2½ | | | |
| 4 | Same lime | 1 | 3¾ | 341 | 528 |
| | Trass | 2¾ | | | |
| 5 | Same lime | 1 | 4 | 297 | 462 |
| | Trass | 3 | | | |
| 6 | Same lime | 1 | 3 | 286 | 143 |
| | Sand | 1 | | | |
| | Trass | 1 | | | |
| 7 | Same lime | 1 | 3¼ | 297 | 165 |
| | Sand | 1⅛ | | | |
| | Trass | 1⅛ | | | |
| 8 | Same lime | 1 | 3½ | 319 | 187 |
| | Sand | 1¼ | | | |
| | Trass | 1¼ | | | |
| 9 | Same lime | 1 | 3¾ | 330 | 209 |
| | Sand | 1⅜ | | | |
| | Trass | 1⅜ | | | |
| 10 | Same lime | 1 | 4 | 330 | 209 |
| | Sand | 1½ | | | |
| | Trass | 1½ | | | |

### *Observations on the experiments of Table* No. XXXI.

All the above mortars were composed of the same old lime as those of the preceding table. The experiments were made in duplicate: those in the first column were prepared in August, 1823, and were left during a year in the air, in a cellar; those of the second column were made in the month of October, 1824, and were left during a year in the air in a chamber where there was no fire. We see that the results are very different: 1st, the five mortars in the first column made of lime and trass only, gave much weaker resistances than the similar mortars in the second column, while it is the inverse with mortars made of lime, sand and trass: 2d, in the first column, the mortars made of lime, sand and trass, gave, in general, better results than the corresponding mortars made of lime and trass only, while it is the inverse in the experiments of the second column.

I am unable to account for the differences shown by these two series of experiments; I cannot say whether, or in what degree, it is to be attributed to their being made at different seasons, and placed in different atmospheres. It is not easy to ascribe such great variations to these two causes; I should rather be inclined to believe that the trass which I used in 1824 was not the same as that used in 1823, and that this has occasioned these opposite results. I purposed repeating these experiments, but my departure from Strasburg in 1825 prevented.

The mortars of the first column of table No. XXXI; were made at the same time as those of table No. XXX; and when, in 1824, I made the experiments of the second column, I also made five mortars like those of No. XXX. and placed them in a chamber—the preceding having been deposited in a cellar. These five mortars, composed of old lime and sand only, remained, like the analogous mortars, without consistence, and were unable to bear any weight.

Seeing that I could get no results with the old moist lime and sand, I made some essays agreeably to the process of Mr. Loriot; they are given in the following table.

### Table No. XXXII.

| No. of the mortar. | Composition of the mortars. | | | | Weight supported before breaking. |
|---|---|---|---|---|---|
| 1 | Fat lime which had been lying a long time wet, measured in paste<br>Sand | | 1<br>2 | 3 | 0 |
| 2 | Lime the same<br>Unslaked fat lime reduced to powder<br>Sand | 1-2<br>1-2 | 1<br>2 | 3 | 0 |
| 3 | Lime the same<br>Unslaked fat lime, &c.<br>Sand | 2-3<br>1-3 | 1<br>1 | 3 | 0 |
| 4 | Lime the same<br>Unslaked fat lime, &c.<br>Sand | 3-4<br>1-4 | 1<br>2 | 3 | 0 |
| 5 | Lime the same<br>Unslaked fat lime, &c.<br>Sand | 4-5<br>1-5 | 1<br>2 | 3 | 0 |

### *Observations on the experiments of Table* No. XXXII.

The process of Mr. Loriot consists in mixing a certain quantity of quick lime reduced to powder, with lime which has been lying for some time slaked and wet; and following his method, I varied the quantities of the two kinds of lime, and yet we see, that I obtained no results. The mortar dries quickly, it is true, on account of the presence of the quick lime, but this is not a true induration. The property of drying quickly is what, no doubt, led Mr. Loriot into error. We see, then, that this mode, offered by the author as yielding very good mortars, gives, in fact, only very bad. It is not surprising, after seeing the above results, that the attempt to repoint the platform of the observatory by this method did not succeed.

Having no good results with the old lime, nor with Mr. Loriot's process, I quitted the erroneous methods of others, and made the following experiments.

### Table No. XXXIII.

| No. of the mortars. | Composition of the mortars. | | | Made immediately. | After 15 days. | After 1 month. | After 2 months. | After 3 months. | After 4 months. | After 5 months. | After 6 months. | After 7 months. | After 8 months. | After 9 months. | After 10 months. | After 11 months. | After 12 months. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| 1 | Fat lime slaked in thick paste .<br>Sand . | 1<br>2½ | 3½ | 99 | 50 | 44 | 33 | 33 | 33 | 33 | 33 | 22 | 22 | 22 | 22 | 22 | 22 |
| 2 | Same lime .<br>Sand .<br>Trass . | 1<br>1¼<br>1¼ | 3½ | 319 | 308 | 308 | 297 | 319 | 308 | 319 | 308 | 319 | 352 | 363 | 341 | 319 | 308 |
| 3 | Fat lime slaked in thin paste<br>Sand . | 1<br>2½ | 3½ | | | | | | | | 33 | 22 | 22 | 22 | 22 | 22 | 22 |
| 4 | Same lime<br>Sand .<br>Trass . . | 1<br>1¼<br>1¼ | 3½ | | | | | | | | 308 | 297 | 308 | 286 | 297 | 286 | 275 |
| 5 | Fat lime slaked to dry powder and measured in paste .<br>Sand . | 1<br>2½ | 3½ | | | | | | | | 0 | 0 | 0 | 0 | 0 | 0 | |
| 6 | Same lime<br>Sand .<br>Trass . | 1<br>1¼<br>1¼ | 3½ | | | | | | | | 286 | 297 | 330 | 297 | 308 | | |

### *Observations on the experiments of Table* No. XXXIII.

These experiments were made at the same time as those of table No. XV, of the first section, and with the same fat lime. I slaked a part as it came from the kiln, giving it only the quantity of water necessary to reduce it to thick paste, and I made therewith the experiments comprised under Nos. 1 and 2. I slaked a part into thin paste, and made with it the experiments under Nos. 3 and 4, and I also slaked a part into dry powder, by giving it a quarter of its volume of water, and with this I made the two series, Nos. 5 and 6. All these experiments comprise the interval of a year, and the several epochs at which they were respectively made are given in the table. The figures of the table give the number of pounds that the mortars supported before breaking.

The series of mortar No. 1, is composed of 1 part fat lime slaked to thick paste, and two parts and a half of sand. We see that the mortar made immediately, acquired a hardness which is not, in fact, very great, but which is passable. The mortars made after fifteen days had nearly one half less consistency; at the end of two months it had two thirds less, and the mortars made after six months had not strength enough to support the weight of the scale pan, &c., which was twenty-two pounds. This result is very remarkable. If we compare it with table No. XXX, of which the mortars being made of lime that had been lying slaked and wet for five years, had no strength, we cannot but think that slaking fat lime into vats and letting it lie there in a wet state, is a mistaken practice. The practice may have been induced from the considerable increase of bulk it gives to fat lime; but the trials I have made show it to be a very bad process, at least with the limes I used.

The series of mortar No. 2, was made of one part of lime in paste, to two and a half parts of sand and trass in equal proportion. The result was very good. It will be noticed that it was best after the 8th, 9th and 10th month. The experiments above having been commenced the middle of November, the greatest resistances correspond to the months of July, August and September. The mortars were deposited in a cellar; but the cellar was one to which external differences of temperature were soon transmitted. In summer, therefore, these mortars were exposed to an atmosphere humid and mild.

The series No. 3 differs from the first only in the lime having been slaked to a thin, instead of a thick paste. The lime was left six months before making any mortar with it. We see that the results were the same, that is to say, were equally bad with those of the first series.

The fourth series differs from the second only in being made of lime slaked thin, while the second series was slaked to a thick paste. I only began to make the mortars after six months had elapsed. We see that the results are good, but rather inferior to those given by lime slaked to a thick paste.

Series No. 5 was made of the same lime, slaked to dry powder. This series was not commenced till six months after the slaking of the lime. The mortars I obtained had no consistency, and crumbled easily between the fingers. The mortars of the first and third series, made at the same period, bad as they were, gave resistance enough to be submitted to fracture. The lime of series No. 5, was slaked by a process analogous to that of Mr. Lafaye, which consists, as I have stated, in plunging the lime for a few seconds into water, then withdrawing it, allowing it to slake of itself, and keeping it for some time before using it; to avoid the embarrassment of the baskets proposed by Mr. Lafaye, I contented myself with throwing on the lime the quantity of water necessary to reduce it to powder, which, in fact, amounts to the same thing. I however obtained no result. It is possible that Mr. Lafaye made his experiments a short time after the slaking of the lime, and comparing them with others made of lime slaked and lying wet for a long time, he found the first to be the best; but it was probably because the lime he employed, like that in the above table, required to be used immediately after being slaked. It appears to me that Mr. Lafaye was deceived in attributing his success to the mode of slaking which he followed.

The experiments of table No. VI were also made with lime slaked to dry powder, mixed with sand and trass. I did not commence these trials till after six months, and I was only able to continue them four months, for want of time. The results are about the same as those of the fourth series, and a little inferior to those of the second.

In the first four series, the proportions were one part of lime in paste, to two and a half parts of sand and trass. To obtain results with the last two series in which the lime was slaked to powder, that might be compared with these, I took care, when making the mortars of the last two series, to reduce this powder to paste, and to measure it in this state.

If we compare the above table with table No. XV, whereof the mortars were made of the same lime, we shall see that in general the mortars left in the air gave results a little weaker than those put in water.

Table No. XXX has shown the bad quality of mortars made by mixing sand with fat lime that had been slaked and wet for some years. The following are corresponding experiments made with the same lime just from the kiln.

## Table No. XXXIV.

| No. of the mortars. | Composition of the mortars. | | | Weights supported before breaking. |
|---|---|---|---|---|
| | | | | lbs. |
| 1 | Fat lime slaked as it came from the kiln and measured in paste immediately . . . . . | 1 | 3 | 68 |
| | Sand . . . . . . . | 2 | | |
| 2 | Same lime . . . . . . | 1 | 3¼ | 57 |
| | Sand . . . . . . . | 2¼ | | |
| 3 | Same lime . . . . . . | 1 | 3½ | 44 |
| | Sand . . . . . . . | 2½ | | |
| 4 | Same lime . . . . . . | 1 | 3¾ | 10 |
| | Sand . . . . . . . | 2¾ | | |
| 5 | Same lime . . . . . . | 1 | 4 | 0 |
| | Sand . . . . . . . | 3 | | |

### *Observations on the experiments of Table* No. XXXIV.

The experiments of table No. XXXIV, were made with lime just from the kiln. The mortars were made immediately, and with a view to ascertain the quantity of sand which this lime would bear. The results shew that the greatest resistance corresponded to one part of lime measured in paste, and two parts of sand, and that the resistances diminished in proportion as the sand was increased. No. 4 had so little strength that it was unable to support the weight of the scale pan; and No. 5 crumbled readily between the fingers. The proportion in general use is one part of fat lime measured in paste, to two parts of sand. Some constructors think that more sand is requisite, but the trials in table No. XXXIV, do not at all confirm this opinion. I regret not having begun by putting a smaller proportion of sand; these experiments should be repeated.

The experiments of tables Nos. XXX and XXXIV are the same, with this difference, that in table No. XXX, lime which had been slaked and lying wet for some years, was made use of, while, in table No. XXXIV, the mortars were made of lime as soon as it was taken out of the kiln. In table No. XXX, with the old lime, I could get no results, whatever were the proportions; while with the same sort of lime fresh from the kiln, the mortars gave some resistance. I do not know how to account for the mortar No. 3, above, being more than one half weaker than mortar No. 1, of table No. XXXIII, which was made and proportioned in the same manner. The differences may be owing to the degree of burning of the lime. It appears to me that fat lime loses quality by being worked up with too much water; but I made no experiments to determine the quantity of water proper to be put in these kinds of mortar; these experiments are yet to be made. It results, nevertheless, from the experiments given in the first section, and from those given above, that lime, whether common or hydraulic, does not bear as much sand as is commonly thought; but it appears to be able to bear more trass, whether alone or mixed with sand; which may be attributed to the combination that takes place, in the moist way, between the trass or puzzolana, and the lime. I purposed making some essays with a view to ascertain the quantities of sand and factitious puzzolana that ought to be mixed with fat lime to give mortars of good resistance; but these proportions can only be fixed after numerous trials, and almost all my leisure had been absorbed by my researches as to factitious puzzolana. I should want, before undertaking the experiments on the proportions of mortars, to have some fixed data, so as to avoid too great a number of useless trials. This is a labour that remains to be undertaken; and it will, no doubt, give different results, according to localities, and according to the quality of lime and factitious puzzolana employed. On summing up, it will be perceived that by whatever manner I operated, only indifferent results were obtained by mixing fat lime with sand; while I obtained very good results by mixing one part of fat lime, measured in paste, with two and a half to three parts of sand and trass taken in equal quantities; as may be seen at the end of table No. XXXI, and in the series No. 2, of table No. XXXIII. It will no doubt be objected to me that several demolitions have been made of masonry built of fat lime; and that the mortars have been found very hard. I will answer this objection; but I am first obliged to present several other experiments.

(TO BE CONTINUED.)

## *Notes on the smelting of Iron by means of Anthracite, and of the origin of the hot blast in the manufacture of that metal; in a letter to the Editor from* BENJAMIN B. HOWELL, ESQ.

In the number of this Journal for February 1829, Vol. III, p. 138, we published the specification of a patent for an improvement in the manufacture of iron, which is alluded to in the subjoined letter. It was the intention of Mr. Howell to have followed up his first successful experiments by manufacturing iron in the large way, at as early a period as circumstances would allow; his works, in New Jersey, however, were too remote from the region of anthracite and of iron to admit of this being done to advantage; and other avocations, it seems, prevented the forming of a new establishment in the vicinity of the mines. We have had but little correspondence with Mr. Howell for some years past, but have known that he still cherished an unfaltering confidence in the correctness of his views, and a full determination to carry them out as soon as it could be done with convenience. The intense interest which was felt upon the subject at the time when Mr. Howell's patents were issued, was productive of an active correspondence, as we partook largely of the confidence and the zeal with which Mr. H. was inspired; and the receipt of the letter which we now publish has been a source of much gratification from the revival of the impressions of ten years ago, and the assurance that what was then anticipated of the final triumph of anthracite in the iron manufacture, is now realized.

Dr. Thos. P. Jones, New York, Feb. 24, 1838.

*Dear Sir:*—I write to recall to your remembrance our correspondence and conversations in 1828, on the subject of manufacturing iron in its various branches, with anthracite as the fuel. It was in that year that I made the successful experiments in reducing the ore, by a single process, to malleable iron, with anthracite, and in puddling pig iron with *heated air*, using that coal for fuel. My Patents bear date in the Autumn of that year.—Prior to that period a good deal of money had been expended in unsuccessful efforts to manufacture pig iron with that coal. In our conversations, and I believe in our correspondence, I expressed my conviction, that these efforts would continue unsuccessful until some plan essentially different from any which had then been practised should be adopted. There seemed both mechanical and chemical difficulties in the way, which no mode then in use appeared likely to obviate, and in every instance since, when I have heard of pig iron having been actually made with anthracite, a critical investigation into the case, has resulted in ascertaining, that however promising it may have been in the outset, in the end it was a failure. Mr. Crane, (in Wales) appears to have been the first to proceed on a large practical scale, and he ascribes its success entirely to the *heated air* —and in this I have no doubt that he is right. When I stated to you the difficulty, owing to the slow combustion of anthracite, of obtaining any thing but a crude product, little better than a mass of scoriæ—entirely undeserving the name of pig or cast iron, being destitute of any portion of carbon—and adverted to the other fact that pig iron remelted with anthracite always *parted* with a portion of carbon; you explained it by remarking that the slow combustion spoken of, caused *all* the carbon to pass off in the form of carbonic acid gas, and no portion of it to unite with the metal, as was the case when either charcoal or coke was used. There was no obviating this with the cold blast—the *heated air* does it effectually, —this, in addition to Mr. Crane's success, *we* have ascertained to our entire satisfaction,—and you will be pleased, I am sure, to learn that we have made good pig iron with *no other fuel* than anthracite; and that too under circumstances of great disadvantage as to the means used, so great indeed, that had we failed it would have been no argument against the process. There are others now trying similar experiments and some have been engaged at it for some time, but in all of which I have yet any precise information, charcoal has been used, to an extent which renders the whole result of doubtful character. Our iron was made without the aid of any other fuel whatever—and I suspect was the first so made on this side of the Atlantic. I mention this to you for several reasons, First, I understand applications have been made for Patents in behalf of Mr. C. and perhaps of others. Mr. C. claims only for the use of heated air, the originality of which as applied to iron, I think I may fairly contest; and secondly, if the application rests on other grounds, then you should know that it has already been done—and certainly before some who I suspect will apply; and thirdly, because as a friend to all improvement I think you will be pleased to know it.

On the subject of heated air, I will state a fact or two and leave you to make the commentary. My patents were taken out in 1828, they were published almost immediately in England—in 1829 the first experiments with it were made there, and the patents followed directly after. By the bye, I have seen in your Journal, two patents, one for the mode of generating the heat, in principle the same as mine, and another for puddling, which, it might be supposed, had been copied from the drawings which I sent you. While the coal could not be used in the first process, that of puddling was of minor importance—now it must become of value.

In using the plural, *we*, I mean my Sons and myself.

Yours, &c. B. B. Howell.

P. S. The maximum of heat used in England and France, appears to have been 700° of Fahr. and but seldom above the melting point of lead. In the course of our recent experiments we reduced the Rhode Island sand stone (you know what that is) to a *soft paste*, and cast iron exposed to the current of heated air, was melted in half a minute; some of the effects produced by this intensely hot blast require to be seen; they can hardly be realized otherwise. It seems to me, that the use of the hot blast is destined to revolutionize the iron manufacture. The diversity in the accounts of its results in England and France may I think be accounted for, without impeaching the veracity of either of the parties in the controversy, as to its real value and influence on the quality of the iron. B. B. H.

## Physical Science.

### *Observations on the Absorption of Gases by Water.* By W. H. Goode, Hampden Sydney College, Va.

The tables of the absorption of gases by water are found in Dr. Turner's chemistry, page 163; one of which is given by Drs. Dalton and Henry, the other by M. De Saussure.

"One hundred cubic inches of distilled and recently boiled water at the mean temperature and pressure, absorb of

| | Dalton and Henry. | Saussure. |
|---|---|---|
| Sulphuretted Hydrogen, | 100 cubic inches. | 253 cubic inches. |
| Carbonic Acid, | 100 | 106 |
| Nitrous Oxide, | 100 | 76 |
| Olefiant Gas, | 12.5 | 15.3 |
| Oxygen | 3.7 | 6.5 |
| Carbonic Oxide, | 1.56 | 6.2 |
| Nitrogen, | 1.56 | 4.1 |
| Hydrogen, | 1.56 | 4.6 |

The estimate of Saussure," Dr. Turner remarks, "is in general too high. That of Drs. Dalton and Henry, for nitrous oxide, according to the experiments of Sir H. Davy, is considerably beyond the truth."

It is of some practical as well as theoretical importance to determine the actual quantity of any gas, that pure water deprived of the atmospheric air it usually contains, will absorb; and whether the absorption of gases by water, obeys any general law.

These points cannot be considered as settled, when the numerical results obtained from one set of observations so far exceed those obtained from another. The disparity between the tables quoted above, is such as to warrant the opinion that one, and perhaps both are erroneous; and leads us to infer that the methods by which they were obtained were as diverse as the tables are wide of a coincidence.

With the plan of manipulation pursued by Drs. Dalton and Henry, to obtain their results, I have no means of becoming acquainted. That of Saussure was as follows.

A flask, *m*, holding 250 cubic centimetres, was filled over the pneumatic trough with the gas to be absorbed, and held inverted for half an hour under the water of the trough, that it might acquire the temperature of this liquid, which ought to be nearly that of the atmospheric air. The mouth of the flask was then closed with a conical ground glass stopper. The weight of this flask empty and full of water was accurately determined.

From this flask about a sixth portion of the gas was poured over the mercurial trough into a receiver filled with mercury. This portion was then poured over the water trough into a flask, *n*, filled with water. The weight of this flask before and after the introduction of the gas gave the volume of this last. This volume being abstracted from that in the flask, *m*, originally, gave the volume of gas still remaining in that flask.

Into the flask, *m*, a quantity of distilled, well boiled, water was poured through the mercury, sufficient to expel all the mercury that had been introduced by the third operation. This flask was then closed at the surface of the mercury, and weighed. This gave the volume of water introduced into the flask.

The gas with the water was now strongly agitated for fifteen minutes, while the flask *m* was held by a pair of pincers, to prevent the introduction of heat by the hand. It was then plunged under the water of the trough, to bring it exactly to its original temperature, opened in an inverted position and closed again under water. Now the water which occupied the place of the gas absorbed, and [or] the difference between the weight of the flask, *m*, now and when it was full of water enabled me to know the volume of gas absorbed." (Annals of Philosophy, Vol. VI, p. 347.)

This method of obtaining the absorption of gases by water appears to be liable to some objections.

The capacity of the flask, *m*, as has been noticed by Dr. Dalton, (Ann. Philos. Vol. VII, p. 218.) "was ascertained when it was dry within; but when filled with air for the experiment, it was wet within, and consequently did not contain as much air, by the quantity of water adhering to the glass."

The water of an ordinary pneumatic trough, is scarcely ever of the same temperature at the surface and at a few inches beneath; by contact with the atmosphere, the particles on the surface acquire its temperature, which causes them to become lighter than those below, and to retain their places: the nonconducting material of which pneumatic troughs are usually constructed, preventing the particles beneath the surface from suffering those alternations of temperature to which the atmosphere and the surface of the trough are subject.

The density of the gas in the flask, *m*, after it had been half an hour under the water is increased; the flask will then hold more gas than it held at the atmospheric temperature.

After the flask is placed on the mercury trough, the gas in passing from the temperature of the water to that of the atmosphere, expands; but the removal of the stopper gives it an opportunity of expanding, without affording any means of detecting the amount. Consequently, the volume of gas in *m*, when it was under the water, was less than the volume in *m* and *n*. This is due to the expansion occasioned by the temperature of the atmosphere; which is higher than that of the water under the surface of the pneumatic trough.

After agitating the gas and water, the flask was again "plunged under the water of the pneumatic trough to bring it exactly to its original temperature." But when the boiled water was admitted into the flask, the gas in it was at the atmospheric temperature, and not at the temperature of the water under the surface of the pneumatic trough, which ought to be, says Saussure, "nearly that of the atmospheric air." Consequently, a diminution of the bulk of the gas took place when the flask was plunged under the water, and when opened a quantity of water entered sufficient to occupy the place of the gas absorbed, and the diminution of bulk occasioned by lowering its temperature.

These sources of error in his method probably militated against the truth of M. de Saussure's results.

The plan adopted to obtain the results given below, for the less absorbable gases, was to make pure and boiled water absorb as much gas as possible by agitating it in contact with the gas; then liberating the gas from a known weight of this water by boiling; decanting and measuring the gas so liberated with Hare's eudiometer, and determining its bulk by the weight of an equivalent number of measures of distilled water.

A globe about four inches in diameter was fitted with a cap into which a stop-cock was screwed air-tight, the other end of the stop-cock screwing into the plate of the air pump; a small tube reaching nearly to the top of the globe, was cemented into that end of the stop-cock intended for the cap. This tube admitted the globe to be exhausted of its atmospheric air after the boiled water was poured in.

The water used in these experiments was twice distilled, in glass vessels; first over the sand bath, and then slowly over a lamp. After being well boiled, a small portion of it was poured into the globe as hot as could be ventured without endangering the cement with which the cap was fastened. The globe was now screwed to the pump plate, exhausted, and attached to a jar on the pneumatic trough containing the gas to be tried, by means of a connecter and stop-cock, cemented into the top of the jar. By depressing it in the water and opening the stop-cocks, the globe was filled with gas, and again exhausted, to free it as much as possible from any atmospheric air that might have remained in it after the first exhaustion.

The time occupied by these exhaustions reduced the hot water originally put in, to the atmospheric temperature.

The globe was then replaced on the jar and again filled with the gas; care being taken that it should remain attached to the jar for a few minutes, in order that compensation might be made for the reduction of the temperature of the gas when it rushed into the void; and that the level of the water within the jar should coincide with the level of that in the pneumatic trough.

The globe was then detached from the jar and agitated briskly for fifteen minutes; during the agitation it was replaced at least once on the jar, and gas admitted to supply the place of any that might have been absorbed.

Another globe about an inch and a half in diameter, with a neck three inches long was counterpoised, and a portion of the impregnated water weighed into it, after the agitation ceased. This globe was then filled with mercury and inverted in a cup of that fluid; it rested on a ring while its mouth dipped under the mercury in the cup. In this position the water which occupied the highest part of the globe was boiled by means of a small spirit lamp, the gas collecting in the upper part, and an equal bulk of mercury flowing out at its mouth into the cup, and as soon as it was sufficiently cool to be handled without inconvenience, it was taken to a water trough in which a quantity of common salt had been dissolved to prevent the absorption of gases by the water decanted, and measured with Hare's eudiometer. The bulk of the gas thus obtained was then determined by the weight of an equal number of measures of distilled water.

This method did not answer with carbonic acid, and the protoxide of nitrogen, which are so readily absorbed that the greater portion of them liberated by boiling, was re-absorbed before they could be decanted and measured.

These gases were generated in graduated tubes filled with well washed mercury to free it entirely from saline matter; and after a known volume of pure water was introduced, the tubes were left undisturbed for twelve or twenty four hours. The bulk of gas exposed to the water in the graduated tubes was corrected for the mean temperature and pressure. Barometric pressure exerted no influence when the absorptions were performed in the globe; but the bulk of gas measured at the trough was influenced both by temperature and pressure, for which due corrections were made.

Care was taken that the vessels in which these experiments were performed should be perfectly clean, and entirely free from grease, or saline matter. Whenever there was the slightest appearance that grease had been communicated from the cap to the water within the globe, it was rejected; the globe was then washed in a hot solution of potassa, and well rinsed three or four times, the last time in the boiled water prepared for the experiment. The mercury with which the tubes were filled, was well washed, and drained through a funnel to free it from impurities.

Precautions were also taken to have the gases perfectly pure, by passing them through such solutions as would take up the impurities suspected to be in them. The hydrogen was prepared in a Woulfe's apparatus, by the action of sulphuric acid or zinc, and passed through a solution of corrosive sublimate and potassa, to render it perfectly pure. The carbonic oxide was prepared from sulphuric and oxalic acids, and remained twenty-four hours over water with a stick of potash in it, supported by a wire, to free it entirely from carbonic acid. The protoxide of nitrogen was passed through water to free it from nitrous acid and nitrate of ammonia.

With these precautions the following results have been obtained. One hundred volumes of water at the mean temperature and pressure absorb, of

| | | | | | |
|---|---|---|---|---|---|
| Hydrogen, | 1.82 | Vols. | Oxygen, | 3.01 | Vols. |
| Carbonic Oxide, | 1.92 | " | Nitrous Oxide, | 55.00 | " |
| Nitrogen, | 2.24 | " | Carbonic Acid, | 139.96 | " |

one hundred volumes of spring water give off by boiling 205 vols. of gas; but the same quantity of pure water absorbs by agitation, 2.44 vols. of atmospheric air.

## Franklin Institute.

### *Minutes of the Board of Managers.*

At a meeting of the Board of Managers, held at the Hall of the Institute, January 24th, 1838,

Mr. John Wiegand was elected Chairman of the Board; and

Messrs. John C. Cresson, and Henry Troth, Curators for the ensuing year.

At a meeting of the Board, held February 21st, the Chairman nominated the standing committees agreeably to the by-laws. On motion, Alfred Langdon Elwyn, M. D. was added to the Committee on the Library; Messrs. James C. Booth and Jacob Peirce were added to the Committee on the Cabinet of Minerals; and Messrs. Joseph M. Truman, John M. Ogden and Briton Corlies were added to the Committee on the Exchange; when the committees were appointed as follows:—

#### *On the Library.*

Henry Troth, *Chairman.*
Isaac Hays, M. D.
Thomas Fletcher,
Isaac P. Morris,
J. Henry Bulkley,
Alexander M'Clurg,
Robert M. Patterson,
Alfred Langdon Elwyn, M. D.

#### *On the Cabinet of Models.*

John Agnew, *Chairman.*
John Struthers,
Isaac P. Morris,
Andrew M. Eastwick,
John S. Warner,
William Hart Carr,
John Gilder,
William D. Parrish.

#### *On the Cabinet of Minerals.*

Isaiah Lukens, *Chairman.*
Samuel Hufty,
Abraham Miller,
William H. Keating,
Charles B. Trego,
Henry D. Rogers,
James C. Booth,
Jacob Peirce.

#### *On Publications.*

Isaac Hays, M. D. *Chairman.*
Samuel V. Merrick,
Matthias W. Baldwin,
John C. Cresson,
Robert M. Patterson.

#### *On Premiums and Exhibitions.*

John C. Cresson, *Chairman.*
William H. Keating,
Alexander Ferguson,
Thomas Fletcher,
Isaac B. Garrigues,
Alexander M'Clurg,
John S. Warner,
John Agnew.

#### *On Instruction.*

Frederick Fraley, *Chairman.*
John Wiegand,
James M. Linnard,
Isaac P. Morris,
Charles B. Trego,
Henry Troth,
Henry D. Rogers.

### *On Monthly Meetings.*

Andrew M. Eastwick, *Chairman.*
Matthias M. Baldwin,
John C. Cresson,
John S. Warner,
William Hart Carr,
J. Henry Bulkley,
William D. Parrish.

### *On the Exchange.*

John S. Warner, *Chairman.*
John Struthers,
Andrew M. Eastwick,
Isaac B. Garrigues,
John Gilder,
Joseph M. Truman,
John M. Ogden,
Briton Corlies.

### *Managers of the Sinking Fund.*

Samuel V. Merrick, *Chairman.*
Frederick Fraley,
Alexander Ferguson.

### *Auditors.*

Isaac B. Garrigues.
William Hart Carr.

### *On Finance.*

William H. Keating, *Chairman.*
Samuel V. Merrick,
Alexander Ferguson.
Frederick Fraley,
Henry Troth,

(Extract from the Minutes.)

John Wiegand, *Chairman.*

William Hamilton, *Actuary.*

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## Mechanics' Register.

### LIST OF AMERICAN PATENTS WHICH ISSUED IN JUNE, 1837.

*With Remarks and Exemplifications by the Editor.*

111. For improvements in the construction of *Rail Road Cars;* Gustavus Plantou, Administrator of Anthony Plantou, city of Philadelphia, June 3.

This contrivance exhibits a rail road car upon castors. The running wheels are to be grooved to embrace both sides of the rail, and these wheels are embraced between, and have their gudgeons in, two cheeks of metal, which unite at top, forming part of a vertical swivel upon which the wheel, with its embracing cheeks may revolve horizontally. The claim is to "the substitution for the axle now in use, of four upright pivot standards, as above described, which contain the wheels, and possess the power of rotation; also their mode of construction, and their application to any form of car or locomotive that may be used on railroads."

There is no probability that a car upon this plan will ever be essayed, and should it be, we are convinced that its career would end there. The idea that such a wheel would readily adapt itself to curvatures, is manifestly fallacious. It is to swivel round by the action of the two flanches of the wheel upon the rail, and that under the weight of the car and its burthen.

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112. For an improved mode of *Dipping Loco Foco Matches*; John Hatfield, Stillwater, Saratoga county, New York, June 3.

After describing the usual mode of dipping the matches by hand into the igniting composition, which is said to be slow and inaccurate, the mode invented by the patentee is described, and this consists in taking a tube, or cup, which is conical, and inserting a sufficient number of matches, to fill the mouth of it; and hold themselves in, the sulphured ends standing outwards. The conical form of the tube will cause the points of the matches to stand free of each other, and when made even, they may be dipped so that the composition shall just cover their points. The claim is to "the use of a tube with a funnel shaped or diverging mouth, by which an indefinite number of matches may be held and dipped at once, as above specified."

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113. For a *Machine for Making and Drying Bricks;* James Hodges, Anderson District, South Carolina, June 3.

The principal novelty in this machine consists in a furnace for drying the bricks. There is a mixing tube for the clay, in which a shaft, carrying knives is, made to revolve in the usual manner; an apparatus of elevators is to carry the clay into the mixing tub, which is also to be supplied with water from a reservoir. A sieve for sanding the bricks, and a revolving brush for oiling the moulds also form a part of the appendages to the machine. The furnace, above spoken of, extends the whole length of the machine, on one side of it. A railway consisting of two tracks parallel to each other, and united at each end by semicircular rails, forms a continuous road upon which carriages, which receive the bricks as they are pressed, traverse round; this railway passes through a kind of oven in the furnace, and through this therefore the bricks are made to pass. Two vertical shafts carry chain wheels, around which an endless chain passes within the semicircular ends of the railway, and to this chain is attached the carriages with the moulded bricks.

The general construction and operation of this machine is sufficiently apparent, but the particular arrangement of some of the individual parts is not clearly made known, although they are claimed both separately and in combination; these claims consist in "the form of the moulds, and the method of drying the bricks by causing them to pass through a heated kiln, on a revolving endless chain, over ways, instead of drying them in the usual manner; also the method of oiling the moulds, and sanding the bricks."

The machine, as represented, is to be operated by horse power, and it appears that the moulding and pressing are to be carried on continuously; we apprehend, however, that under the arrangement exhibited, so far as it can be understood, there will be found practical difficulties, as the machine is complex. With respect to the drying we are entirely at fault, as it appears to be utterly impossible to effect this in the way described, during the time the bricks are being made: the oven, to be effective, should, we think, be half a mile long, at least.

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114. For improvements in *Boilers for Generating Steam;* James J. Rush, machinist, Philadelphia, June 3 (See specification.)

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115. For improvements in *Trusses for the radical cure of Hernia;* Heber Chase, M. D., city of Philadelphia, June 10. (See Bibliographical Notice, p. 95.)

116. For improvements in the *Machine for Planing Boards;* Samuel Whitney, Dunstable, Hillsborough county, New Hampshire, June 3.

In this machine there is a horizontal planing wheel, furnished with cutters, or irons, for roughing and finishing the board. The boards are to be fed in between, and to be drawn on by rollers, as in most other planing machines. The claims, necessarily, are restricted to the particular manner in which the respective parts are combined together, and made to operate. Upon the face of the thing there is not any superiority in this over the machines which have preceded it; but of this it might be unfair to pronounce a definite judgment from a drawing and description only.

117. For an improvement in the *Cotton Press;* Gideon Fitz, Clinton, Hinds county, Mississippi, June 10.

The claim in this press is "the mode of connecting the screw with the cotton box, by placing the nut of the screw under the box, on a sill, or sills, which sill or sills may be let into the ground in a horizontal manner, and be covered over with earth a few inches deep, to admit the horse or team which carries the lever round, to pass over the sill or sills." In this press the inner end of the sweep rests on a collar and forms the nut of the screw, which as it is carried round, causes the screw and the follower which is attached to its upper end, to rise without revolving, and to press the cotton in the cotton box situated above it.

118. For an improved *Machine for separating Wild Peas, or other round seeds from grain;* Lester Butler, Cobleskill, Schoharie county, New York, June 3.

This machine consists mainly of a wheel, or round table, which is made to revolve horizontally. Its surface is dishing, or inclines towards the centre, where it is open for the round seeds to fall through it into a receiver extending under the opening. The seed to be cleaned is put into a hopper furnished with a shoe, and the grain falls down nearly on to the middle of the inclined rim, which is kept revolving by its shaft. There is a contrivance for agitating the seed as it passes round, and from the inclination of the rim, the round seeds pass towards, and fall through, the open centre. The wheat, or other elongated grain, is carried by revolving brushes, to the periphery of the wheel, where it falls into a separate receiver prepared for it.

The claim is to "the principle of separating round seeds from the grain, by a horizontal inclined wheel, projected in such a manner as to admit the revolution of the wheel, or plane, a separation of the round seed from grain, and the process of raking the deposit of the hopper, and gathering the grain after being cleansed, into a receiver attached to the machinery."

The specification of this patent is very far from being a model for such instruments, as it is very deficient in clearness.

119. For improvements in the *Machine for sawing Clapboards;* Samuel Goss, Milford, Hillsborough county, New Hampshire, June 3.

"The applicant claims no part of said machine as new, excepting the guide, as specified, connected with the screw gauges, and the shelf moved by the arm, for sawing clapboards." The guide and shelf spoken of constitute the machinery for canting the bolt at every cut, so that a circular saw may alternately cut a thin and thick edge.

120. For an improvement in the *Machine for Sawing Shingles;* Samuel Goss, Milford, Hillsborough county, New Hampshire, June 3.

The claim in this, as in the clapboard machine, is to "the guide moving on a pivot, as specified, and connected with the arms and screw gauges, for sawing shingles." The principle of action is analagous to that of the last machine, with this difference, that the tilting of the bolt is endwise.

121. For an improvement in the *Process of Leaching Ashes;* Garret Clement, Canadaigua, Ontario county, New York, June 10. (See specification.)

122. For a *Machine for breaking and softening Hides, Skins and Leather;* Eli Kendall, Newton, Middlesex county, Connecticut, June 10.

The skins are made to pass over a large roller, to which they are confined, and on which they are carred forward regularly by means of a feed roller which presses upon it. The breaking and softening is effected by means of elastic knives set spirally around a third roller, revolving above that first named. The claim is to "the spring or elastic breakers constructed and applied to the machine for breaking and softening hides, skins, and leather as above described."

123. For an improvement in the mode of *Making a Batting, or Web, for Hat Bodies;* Thomas Blanchard, city of New York, June 14.

The claim made by the patentee will afford a good general idea of the operation of the above named machine; its particular construction cannot be given without the drawings. The *fancy,* and other rollers are employed to prepare the fur, in the same manner as in some other machines. And the patentee says that "the quick fancy that throws the fur from the doffer will raise a sufficient current of air by its rapid motion to carry the fur to the roller, with the assistance of the draught of the fan. I do not claim the fan as my invention, nor the wire vellum apron, nor any part separately. But I do claim as my improvement, or invention, the forming of a batt or web, of fur by throwing the fur into a chamber, and depositing it on an endless web of wire cloth, or vellum, revolving around two extended rollers, and by exhausting said chamber of air by a revolving fan on the other side of said chamber; the air passing through the wire cloth deposits the fur upon it, and draws it tight upon the wire cloth, at the same time the wire cloth is performing its progressive motion, and carries the fur under a vibrating roller which hardens it to a sufficient tenacity to be handled and formed into hat bodies, or used for naps; and the arrangement and combination of the above machinery, and parts of machinery, in the manner described and set forth, and for the purposes aforesaid."

124. For a *Stove for heating Irons for Hatters, Tailors, &c.;* Bartholomew W. Taber, Falmouth, Barnstable county, Massachusetts, June 10. (See specification.)

125. For an improvement in the method of *Protecting Timber from destruction by Worms and Dry Rot;* August Gotthilff, City of New York, June 14. (See specification.)

126. For an improvement in the *Plough*; Bancroft Woodcock, Mount Pleasant, Westmoreland county, Pennsylvania, June 14.

The numerous patents for ploughs hardly admit of any other novelty than some particular mode of constructing certain parts, so as to render their renewal easy as they wear out, or of putting the respective parts together. The claims made by Mr. Woodcock are "with reference to the share, the making it with plane surfaces instead of curved ones; continuing such surfaces to the shoulder on each side, so as to leave the metal throughout so thin that when it wears off by use, the share will still present a thin edge to the ground. Also the reversing cutter received into a recess on the land side, and capable of having either of its edges presented forward, so as to form the cutting edge of the plough, and secured in its place on the land side by a wedge, or wedges, or in any other manner which may be preferred. Likewise the mode of forming the renewable point as specifically set forth."

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127. For improvements in the *Machine for Breaking Hemp and Flax;* John Warren, Westbrook, Cumberland county, Maine, June 14.

This is an ingeniously contrived machine, and it has been preceded by several others, meriting the same character; but none of which have been found to operate advantageously in continued use. In this machine the hemp or flax is held in a clamp, from which it hangs down vertically, there being the necessary contrivance to allow it to be raised up and down, as it is fed between breakers which slide horizontally, the slats on one passing between those of the other.

The claim is to the "manner of constructing a machine for breaking hemp and flax, as described; that is to say, with a movable brake acting horizontally upon a stationary brake, by means of cranks or other analagous contrivance, with metal or other blades attached to them, and operating in the manner set forth. Also the arrangement of the clamp, and other parts of the feeding apparatus by which they are adapted to operate in conjunction with the said horizontal brakes."

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128. For an improvement in the *Machine for Breaking and Dressing Flax and Hemp;* Harvey Lull, Ithica, Tompkins county, New York, June 14. (See specification.)

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129. For an improvement in *Anthracite Coal Stoves;* Aaron O. Price, Newark, Essex county, New Jersey, June 14.

The main feature of novelty in this stove, or grate, is the enclosing an open fire place by transparent doors, which may be made to open or to slide laterally.

"The principle claimed by me as original is the substitution of an open grate in a mica or glass case, instead of a furnace, or pot to contain the coal. The advantage of my principle is the whole fire being visible, giving a beautiful and pleasant light, and the heat radiated without obstruction, making it as safe as any close stove, with the advantage of an open grate." Notwithstanding all the advantages set forth, we do not believe that this stove is destined to go into extensive use.

130. For improvements in *Harness for Horses in Shafts;* Robert Beale, city of Washington, June 15.

This harness is so constructed, that the driver can very readily disengage the horse, leaving him untrammelled, and freeing him entirely from the carriage. The claim made is to "the mode of constructing the apparatus described, by means of which the two halves of the back band, or saddle tug are connected together, and instantaneously disengaged, so as to free the horse from the shafts of the carriage; in combination therewith I also claim the manner herein set forth of causing the horse to draw by means of what I have denominated a tug plate, and trace staple, constructed and operating substantially in the manner herein shown."

The apparatus described is simple, and would be efficient; but experience proves that no device of the kind will go into general use; when first exhibited, persons are pleased with them, but riders do not intend to be run away with, or to carry with them a perpetual memento that they are liable to this accident; and even when this does occur, there would frequently be more danger in suddenly disengaging the horse, than in taking the risk of keeping him in the shafts.

131. For an improvment in *Capstans for Ships*, and for other purposes; Increase Wilson and Francis Beckwith, New London, Connecticut, June 15.

This capstan has two vertical barrels, instead of one, and these are about a foot in diameter, and placed six inches apart. At their upper and lower ends they are to be geared together by cog wheels, to insure their uniform action. The head of one projects up, as usual, to receive the levers, or handspikes, by which they are to be turned. A number of grooves or scores, is cut round each barrel to receive the rope, which is to go round the two, crossing between them. "The size of the barrels, wheels, and scores, as also their number, may be varied, and also the materials of which they may be made. What we claim, therefore, as our invention, and desire to secure by letters patent, is the combination, as before described, of two barrels with wheels, scores, and ropes so arranged as to receive the rope uniformly on to one end of the barrels, and conduct it steadily on and off the other, as specified."

132. For an improvement in the *Machine for Scraping Hides;* Reuben Shailor, Haddam, Middlesex county, Connecticut, June 19.

The claim is to "the combination and arrangement of the several parts of the machine for scraping hides, as set forth, by which the scraping is performed by placing the hides on the surface of a revolving cylinder, and causing a frame containing several knives, or scrapers, to move by common band or cog gearing, backward and forward over the hides, at right angles to the motion of the cylinders, by which they are thoroughly scraped in every part; the knives, or scrapers, having also an alternate vertical movement, caused by the vibrating lever, or beam with a wheel in each end passing over inclined planes near each end of the frame."

133. For an improvement in the process of *Divesting Caoutchouc of its adhesive properties, &c.;* Charles Goodyear, city of New York, June 17. (See specification.)

134. For an improvement in the construction of *Mopheads*, and the mode of securing them upon handles; Jacob Howe, Worcester, Worcester county, Massachusetts, June 15.

The head which is to hold the materials which are to form the mop, consists of two parallel bars, which, by means of a screw that passes into the handle, may be drawn together so as to hold the cloth, or other material.

135. For a *Machine for cutting Dye Wood;* Lucilius H. Moseley, Poughkeepsie, Dutchess county, New York, June 22.

A vertical shaft is made to revolve by means of bevil gear, or otherwise, the upper end of this shaft carries a conical cup of cast iron, the apex being downwards, and the mouth sufficiently large to receive the ends of such stuff as is to be cut. One or more knives are to be fixed in the cup, extended from the bottom to the top, and the log of wood is clamped in a sliding gate above the cup, so that the wood will descend by its own gravity. When small pieces are to be cut, which cannot be held in the clamp, they are put into the cup, and are prevented from revolving with it by means of a stationary division piece to be affixed to the machine for that purpose. The claim is to "the employment of a hollow conical cup to carry the cutters, in the manner set forth; and also to the using in such a cup, a check, or division piece, by which the smaller pieces of stuff may be cut."

136. For *Mills for grinding Coffee and other substances;* Hiram Twiss, Meriden, New Haven county, Connecticut, June 19.

This mill has a cylindrical nut, which revolves in a hollow cylindrical case, to which there are appended several contrivances alluded to in the claim, such as a cleaning cylinder, and a cracker, neither of which will be here described, and we think them of but little value, whilst they render the machine unnecessarily complex. There are but few articles of domestic economy the office of which is better performed than that of the ordinary coffee mill, leaving little to be desired excepting in the human machine, by the aid of which the berry is to be roasted, and the beverage prepared.

137. For improvments in the instrument for *Extracting Hair from Skins;* Edward Flint, city of New York, June 30.

The patentee denominates this instrument a *clamp* fur knife, and claims "the combination and arrangement of the clamp with the cushion and blade, confined and operated by means of a spring, hinge, or pivot, or otherwise, and together forming substantially, in the manner described, a new hand instrument, knife, or pincers, for extracting hairs from fur skins." Although this instrument cannot be called complex, it cannot be readily described without giving a greater space than is thought proper to an article in which but few would feel an interest.

138. For improvements in *Managing Saccharine, Vinous, and Acetous Fermentation;* John J. C. Sheridan, city of London, a subject of the King of Great Britain, June 30.

The specification of this patent is of great length; we intend, therefore, hereafter, to prepare an abstract of it, furnishing all the details, so far as they may be necessary to make the nature and merits of the process known.

139. For an improvment in *Lamps for Lighting Houses;* Samuel Rust, city of New York, June 30.

The metallic stoppel of this lamp is ground so as to fit into the neck of a glass lamp, passing in like a cork, or rather like the ground stopper of a decanter; thus avoiding the troublesome appendage of a screw, or the imperfect device of a cork. The wick in this lamp is to be raised by a roller, as in Mr. Rust's other lamps. We have them in use, and find them excellent. The claim is to the grinding in of the stopple, as described.

140. For improvments in the *Machine for Morticing Timber;* Thomas H. Hoskins, Springfield, Clark county, Ohio, June 30.

The bed of this machine is an inclined plane, the chisels working in this direction instead of vertically, as in other morticing machines. There is also considerable peculiarity in its construction in other respects, which cannot be understood without the drawing. The claim is to "the general arrangement and combination of the operating parts thereof, as peculiar in their character; that is to say, the arrangement of the wedge formed pieces, by which, and their connection with the treadle, the mortice chisel is made to traverse backward and forward on an inclined plane, together with the arrangement of the straps, weights and screws, for moving the traverse bar."

141. For improvements in *Lamps and Lamp Torches;* Jeremiah Marting, Boston, Massachusetts, June 30.

The drawing represents a swinging lamp, or torch, such as is used by our firemen. The burner, or tube, for containing the wick, is surmounted at its lower end by a cup into which any superfluous oil may flow from the wick, and thence through holes leading into the body of the lamp. The purpose answered by this cup, and the holes above spoken of, is the same with the analogous contrivance in our common lamps, where the stopple is made dishing, and there is a hole for ventilation, and to allow the waste oil to return in the lamp. The claim is to "the said improvement as above described, for the purpose set forth."

142. For an improvement in the *Open Fireplace, or Grate;* Roger M. Sherman, Fairfield, Fairfield county, Connecticut, June 30.

The heated air from the fire is to circulate through several rectangular flat boxes, called radiators, and connected together by flues. There is nothing very peculiar in the general arrangement, but still the form of the apparatus differs sufficiently from that of some others constructed for the same purpose, to justify the grant of a patent. The claim is to "the combination of the open fireplace with the radiators placed over it horizontally. connected by several flues with the chamber, and with each other, as described."

143. For an improvement in cast iron *Press Cases for Tobacco;* Granville D. Allen, Richmond, Virginia, June 30.

This press case is a cast iron box, within which the box into which the tobacco is to be prized, is enclosed, and fits it closely. The press case has flanches, or ears, at its corners, to receive screw bolts, which keep it firmly together, and allow it to be taken apart for the removal of one box, and the insertion of another. The claim is to "the press case with diagonal flanches, or ears, connected by screws, or key bolts."

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147. For an improvement in *Constructing the Frame work of a Portable Horse Power;* John A. Nelson and J. P. Ross, Lewisburg, Union county, Pennsylvania, June 30.

The frame work, for a horse power, above alluded to, is believed by the patentees to be peculiarly firm and compact; they "claim the constructing it with the sill and cap pieces crossed in the manner described, and connected together by upright posts, with girths to brace them and to sustain the gearing; the whole combined together substantially in the manner set forth."

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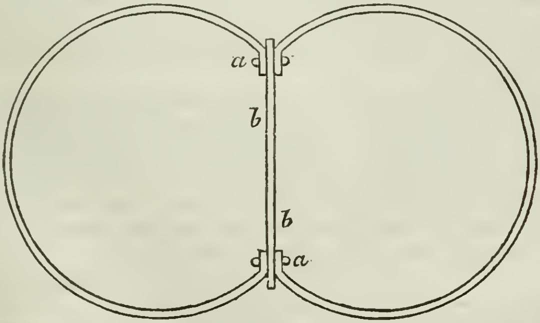
## SPECIFICATIONS OF AMERICAN PATENTS.

### *Abstract of the Specification of a Patent for improvements in boilers for generating steam for Steam Engines; granted to* JAMES J. RUSH, *city of Philadelphia, June 3rd,* 1837.

The general principle upon which I construct my boilers is that of combining together two, three, or more sections of cylinders, in lieu of two, or more, perfect cylinders, placed side by side; such sections of cylinders having tubes within them, constructed and operating in the manner of those ordinarily used in locomotive steam engines. The accompanying sketch is a cross section of two such cylindrical sections united together, by rivets or bolts, *a, a,* and to the diaphragm, or plate, *b, b,* extending the whole length of the boilers. The cylindrical parts of such a boiler may be three feet six inches in diameter, and their conjugate diameters six feet, more or less. Such boilers do not differ in the general mode of arranging the tubes for the passage of heat, from those in general use. I intend in general, to surmount these boilers by steam chambers, which steam chambers, however, I do not claim as constituting any part of my invention. Three or more sectional cylindrical boilers may be connected together in the same way, with the former. The combining together of boilers consisting of sections of cylinders, as herein described, constitutes my first improvement.



My second improvement consists in the using of sheets of wove wire, or wire gauze, of a fine texture, similar to that employed in bolting machines, to prevent the rising of the water into the steam chamber, and the consequent throwing of a quantity thereof, into the cylinder, intermingled with the steam. For this purpose I stretch sheets of wire gauze upon suitable frames, which frames are allowed to float upon the surface of the water in the boilers; or I stretch such sheets of wire gauze across the tubes which connect the boiler, with the steam chambers, or I place them in any other manner which convenience or the particular construction of the boiler may suggest, so that the sheet, or sheets may be interposed between the water in the boiler, and the steam chamber, or reservoir; where it will have the effect of breaking the rising bubbles, and of separating the water and steam from each other.

I am aware that wisps, or tangles of wire have been placed in steam pipes, with a view to the obtaining of the end proposed by me, but my plan of interposing a sheet of wire gauze, just above the surface of the water, which I have found to answer the intended purpose in the most perfect manner, is, as I believe, essentially new.

What I claim as constituting my improvements in boilers for the generating of steam is, first, the combining together of two, three, or more boilers in cylindrical sections, in the manner, or upon the principles herein fully set forth; and, secondly, the placing of a sheet of wire guaze, or wove wire, at or near the surface of the water in steam boilers, substantially in the manner, and for the purpose above made known and described.

James J. Rush.

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## *Specification of a Patent for a new method of leaching ashes for manufacturing Potashes; granted to* Garret Clement, *Canandaigua, Ontario county, New York, June* 10*th*, 1837.

Let the Leach be set in the usual manner and of such size as is found convenient; but the size most approved, is such as to contain ten bushels of ashes.

In filling the leach, spread on the bottom one bushel of slaked lime, and in the centre of the leach, place a small quantity, about three quarts, of unslaked lime, then put in five bushels of ashes, and on the ashes pour fifty gallons of boiling hot lime-water; next place in the centre of the leach one peck of unslaked lime, heated in the arch to a red heat, and on the lime place half a bushel of ashes taken hot from the arch; next put in five bushels of ashes, and on this pour hot lime water until the leach begins to run. And as soon as the hot water has run down in the ashes, put on cold water as much as is necessary.

What I claim as a new invention in this specification, and for which I wish to secure Letters Patent, is the use of hot unslaked lime and hot ashes, and the manner of disposing of them in setting up the leach, by means of which a degree of heat is produced and continued in the leach greater than can be secured by any other known means, and in this manner a leach is run down in six hours, being a shorter time, and the strength of the ashes more fully extracted, than by any other known method.

Garret Clement.

*Remarks by the Editor*—We are really at a loss to discover the rationale of the operation of heated unslaked lime, as above used in the manufacturing of Potash. The heat may, undoubtedly, facilitate the process, but to afford this, unslaked lime is certainly not necessary; heat has, in fact, been applied by others as fully as it is proposed to be applied in the foregoing process.

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### *Specification of a Patent for a Stove for heating irons for the use of Hatters, Tailors, &c.; granted to* Bartholomew W. Taber, *Falmouth, Barnstable county, Massachusetts, June* 10*th*, 1837.

To all whom it may concern, be it known, that I, Bartholomew W. Taber of Falmouth, in the county of Barnstable, and State of Massachusetts, have invented an improved stove for heating irons for the use of Tailors, Hatters, &c., and I do hereby declare that the following is a full and exact description thereof.

This stove is intended to be used with anthracite as fuel, but other kinds may be burnt in it. The most convenient form is rectangular, the plates being, in general, of cast iron, and put together in the usual manner. The fuel is contained in a grate with front and bottom bars such as are commonly employed in open fire places, and frequently in close stoves, there being a door in front by which the grate may be enclosed, and another above it for replenishing the fire. The receptacles for the irons to be heated are at each side of the fire, and consist of small compartments, like ovens, which are closed by doors that slide up and down; each of these compartments must be sufficiently long and deep to contain the goose, or pressing iron, which is to be laid upon its side within it, the handle standing out, so that when a door or shutter which closes the compartment is slid down, the handle of the iron is without, exposed to the air, there being two notches in the lower edges of each of these sliding shutters, to allow it to close over the two ends of the handle.

The distinguishing feature of this stove, as applied to the heating of irons is, that the irons are exposed to the direct action of the fire, there being bars at each end of the grate, which bars constitute the division between the fire and the compartments, so that the faces of the contained irons are exposed to it, as they would be if exposed against the front bars of an open grate, whilst, at the same time, they are confined within a small oven, or enclosed compartment, in which they will be rapidly heated. For an exemplification of the manner in which this stove may be constructed, I refer to the drawing thereof deposited in the Patent Office.

What I claim as my invention, and wish to secure by Letters Patent, is the constructing of a stove for heating irons, having compartments to receive them in which the irons are exposed to the direct action of the fire, whilst they are enclosed by doors, shutters, or slides substantially in the manner herein described; not intending by this description to limit myself to any particular form of stove, or to the number of heating compartments, or of the sides thereof on which such compartments may be situated.

Bartholomew W. Taber.

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### *Specification of a Patent for a method of protecting timber from destruction by worms, dry rot, or other processes of spontaneous decay; granted to* August Gotthilff, *city of New York, June* 14*th*, 1837.

To all whom it may concern: be it known, that I, August Gotthilff, of the city of New York, in the state of New York, have invented a method of protecting timber from destruction by worms, dry rot, or other processes of spontaneous decay, by the application of materials thereto, which have not heretofore been applied to the same purpose, in the same way; and I do hereby declare that the following is a full and exact description thereof.

I saturate the timber with either of the following articles, either alone or combined with common salt; or I use two or more of them so mixed, or combined, as may be preferred; that is to say, I take common vegetable tar, pitch, the tar-like residuum from the manufacture of illuminating gas, in gas works where animal or vegetable oil, rosin, a mixture of oil and rosin, or any vegetable oleaginous or resinous substance is employed for the production of the gas, and I melt or combine them together in such proportions as may appear best, adding, in most cases, to these resinous materials, and more especially when the timber to be saturated is of a very porous kind, from one-eighth to one-fourth part of their weight of common salt.

As these materials are to enter, and fill, the pores of the wood, by the aid of heat, it may be necessary, sometimes, to dilute them. and this I do by means of spirits of turpentine, or of an analogous solvent distilled from any of the above enumerated materials; this, however will rarely be necessary. To effect perfect saturation, I place the timber and the resinous materials together, in suitable metallic troughs, or tanks, the quantity of the resinous matter being sufficient to cover the timber; the whole is then submitted to a temperature of from three to four hundred degrees of Fahr. scale, for a term which may vary from one to twelve, or more, hours, dependent upon the size and nature of the timber; after which the redundant heated fluid is to be drawn off, when it will be found that the timber will be saturated throughout. The well known processes of exhaustion, and pressure may be applied to promote the saturation, but it is not believed that this will ever be required.

What I claim as constituting my invention is the application of the tar, pitch, and other analogous materials, obtained from vegetable substances, by the agency of heat, to the various kinds of timber, in the manner described, so as completely to saturate the same; using these various materials, in some cases, in combination with common salt; but it is to be distinctly understood, that I claim the saturating of timber with the vegetable products within mentioned, by submersing the timber therein, in a heated state, without, as well as with, the addition of common salt.

AUGUST GOTTHILFF.

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## *Specification of a Patent for a machine for Breaking and Dressing Hemp and Flax; granted to* HARVEY LULL, *Ithaca, Tompkins county, New York, June 14th,* 1837.

To all whom it may concern, be it known. that I, Harvey Lull, of Ithaca; in the county of Tompkins, and State of New York, have invented an improved machine for the purpose of breaking and dressing hemp and flax; and I do hereby declare that the following is a full and exact description thereof.

Upon a main shaft, the gudgeons of which are sustained in any suitable frame, I fix two circular heads, which for an ordinary sized machine for hemp may be three feet in diameter, and three feet six inches apart. Between these heads there are to be fluted breaking rollers, which have their bearings near the peripheries of these heads, or in circular plates. These rollers may be of cast iron, or of wood covered with metal; they extend from one circular head to the other, and may be ten inches in diameter. They are fluted from end to end by deep angular flutes, each of which may constitute two sides of an equilateral triangle, and of these there are upon each roller usually ten in number. Two or more such rollers are placed at equal distance apart, with their teeth projecting beyond the edges of the plates in which their gudgeons revolve. Knives for dressing the hemp, or flax, extend across from head to head, there being one in advance of each roller, nearly in contact with it, and having its blade in the direction of the peripheries of the circular heads, and on a level with them, whilst they are strengthened by a strip on their backs at the under sides of them.

The breaking is to be effected by means of metallic plates, or slats, with the aid of the above named fluted rollers, within the flutes of which they are to be received, their conjoint action effecting the object. These slats may be of the same length with the rollers, four or five inches wide, and one-fourth of an inch thick; and they are to be so fixed that they may be made to pass to a greater, or a less depth within the roller flutes, as the breaking proceeds; the rollers also must be made to revolve on their own axes, and both of these objects I effect in the following manner.

I prepare two flat circular plates, or hoops, usually of cast-iron, which are to be of such size, and so attached to the frame of the machine, as that they shall surround the fluted rollers, near each of their ends. One of these hoops is round on its inner edge, and the opening therein of such diameter as just to allow the fluted rollers to revolve, and to be carried round by the main shaft, within, without touching it; this plate or ring, is about three inches wide. The opposite plate differs from this first in being furnished with teeth on its inner edge, which mash into the flutes, or teeth, of the fluted rollers, which play with freedom in them. The effect of this arrangement, is that when the main shaft, carrying the cylinder of fluted rollers and knives is made to revolve, the individual rollers will likewise revolve on their own axes.

The slats which are to pass between the teeth of the fluted rollers are received between the two last described hollow circular plates, extending from one of them to the other, and sliding in and out, in notches, or grooves, prepared for that purpose, their planes pointing towards the centre of the main shaft, and standing in the middle of each of the teeth, by which the rollers are turned. The number of these slats may vary, but eight will usually answer the intended purpose; they occupy the upper portion of the machine, commencing about twenty degrees from its top on the feeding side, and extending about one-fourth of the way round.

I have said that these slats are made to slide in and out, as may be required, and this sliding I effect by making a projecting tongue on each end of them, which tongues are received into grooves upon movable curved plates adapted to the inner sides of the hoops, or rings, by which the slats are sustained; the grooves, above named, form inclined planes, so placed that when the curved plates are made to slide back or forth within the circle, the slats are simultaneously forced in or out; they are made to slide by means of a cranked lever attached to their ends, and which crosses the machine. Instead of tongues, there may be notches on each end of the slats, having inclined tongues, or fillets, fitted into them; and the sliding of the slats also, may be effected in other ways.

When this machine is used, the main shaft is to be made to revolve by any competent power; the tow or flax is to be held in the hand or in a gripe made for the purpose, and fed in upon the revolving rollers, by which it will be carried under the slats, which, by means of the cranked lever, are forced down as the breaking proceeds, whilst it is at the same time dressed by the knives, which separate the shivers from it, and clean it in a very perfect manner. When one end of the handful has been thus dressed and cleaned, it is withdrawn, and the other end is fed in and cleaned in a similar manner. For flax the machine should be of smaller size than that designated; but considerable latitude may be allowed in this particular.

Having thus fully described the construction and operation of my machine for dressing and cleaning hemp and flax, I do hereby declare that, I do not intend to claim the fluted rollers, the slats, or the dressing knives in their individual capacities, as of my invention, these having been before used in machines for the same purpose, but combined together, and operating, in a manner essentially different from that herein described. What I do claim, therefore, is the general combination and arrangement of those parts substantially as above set forth; that is to say, the fluted rollers carried round by a revolving shaft, and having an independent revolution of their own, on their individual shafts, which revolution is effected by teeth taking into the teeth, or flutes on the rollers in the way described; and this I claim in combination with the dressing knives, and the movable slats, which latter are made to pass simultaneously to a greater or lesser depth within the flutes of the rollers, in the manner, and for the purpose herein fully set forth.

Harvey Lull.

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## *Specification of a Patent for divesting Caoutchouc, or India Rubber, of its adhesive properties, and also of bleaching the same, and thereby adapting it to various useful purposes; granted to* Charles Goodyear, *city of New York, June* 17, 1837.

To all whom it may concern: Be it known, that I, Charles Goodyear, of the City of New York, in the State of New York, have invented, or discovered, a new and improved mode, or process, of divesting Caoutchouc, Gum Elastic, or India Rubber, of its adhesive properties; not at the surface merely, but for some distance below it, and, under certain circumstances, throughout its whole thickness; which process is applicable to that material, either in its natural state, or after it had been dissolved in any of the known solvents thereof, and made into sheets, or employed as a covering to cloth, or other substances; and I do hereby declare that the following is a full and exact description thereof.

I employ the various acid solutions of the metals, either saturated, or partially saturated, and with such metallic solution I wash over the surface of the caoutchouc, of which I mean to destroy the adhesive property; or instead of washing the surface of the caoutchouc, I dip it, or the article coated with it, into such a solution. If the article is cloth coated on one side only with the solution, it is necessary, in general, to protect the uncoated side from the action of the acid solution, more especially when the more corrosive acids are used; the cloth may, in this case, be united together at the edges, and at the ends, so as to form a sort of bag, capable of being dipped into the metallic solution without its interior being brought into contact therewith.

The metallic solutions are not, by any means, equally effective in destroying the adhesiveness of the caoutchouc; the stronger acids being in all cases preferred, as being perfect in their action; nor is it indifferent what kind of metal is employed. The strong nitric acid, undiluted, is that which I in general prefer; and among the metals, I prefer either copper or bismuth, forming a nitrate of copper, or a nitrate of bismuth, as the full effect is produced by these solutions in from one to five minutes. After the action is thought to be complete, the article acted upon is to be washed with water, so as to remove the whole of the acid solution, and it will be found that not only the surface of the caoutchouc will resemble that of a soft cloth, but that this surface may be worn off to a considerable depth, and the new surface not manifest the slightest tendency to adhesiveness; it is indeed so far altered in its properties as to resist, to a considerable extent, the action of those menstrua by which it is ordinarily dissolved; it may, for example, be washed in spirits of turpentine, or in the oil of sassafras, without being rendered tackey; and it will equally resist the action of solar or of artificial heat, under all ordinary temperatures.

I have thus fully described what I believe to be the best modes of carrying my discovery into effect, by the use of metallic solutions, and have said that they are not equally efficacious; some of them, I am well convinced, would not answer the purpose at all, as the acetate of lead, for example, and probably all the solutions of metals in the vegetable acids; and there are some which will produce the effect in a less perfect manner than the nitrates which I have named, or which will require a much longer time for their complete action; but these are differences which it is not necessary, or possible, to particularize; neither is it essential to a full knowledge of the means which I have adopted to produce the intended effect. I have also spoken of dipping the article to be acted upon into a metallic solution, or of washing its surface therewith, but other modes may be devised of producing the same effect by means substantially the same. I have sometimes covered the surface of the caoutchouc with the metallic powder known by the name of bronze, and have afterwards washed it over with nitric acid, which has produced the same effect as the washing it with, or dipping it in, the metallic solution, such a solution being in this case immediately produced by the action of the acid upon the metal.

It is a common practice to add some of the absorbent earths, or some pigment, to the dissolved caoutchouc, and when this is done the metallic solution may be readily made to operate to a greater or less extent throughout the whole mass of a sheet of considerable thickness.

Instead of the process above described, or preparatory to it, I combine the caoutchouc with quick lime, as I have found this earth preferable to either of the others in fitting the sheet caoutchouc to be acted upon throughout its whole thickness by the metallic solution; but besides this, the lime has the property of bleaching the caoutchouc, and of giving to it a surface and texture adapting it to the receiving impres sions from copper plates, or by other modes of printing, rendering it, either alone or when used as a coating for cloth, applicable to the purpose of printing charts, or other devices. The caoutchouc, so prepared with lime, will, however, be rendered adhesive by the action of heat, or of solvents, unless the metallic solutions be applied to it; in which case much of the whiteness communicated to it by the bleaching property of the lime will disappear. I, however, view my discovery of the action of lime, in the way in which I have applied it, as of great importance, and therefore proceed to point out the manipulation which I have found necessary to its successful use.

I slake a portion of the finest quick lime, and then mix and agitate it with so much water, as that it shall not be thicker than milk, when on allowing it to stand at rest, all the coarser particles contained in it will rapidly subside; the upper portion, containing the finer particles, is then to be poured off, and the fine lime allowed to subside, the water left on the surface of this being then poured off, it is obtained in a state fit for incorporation with the caoutchouc when in that form of thick paste into which it is brought by the manufacturer preparatory to its being rolled into sheets.

What I claim as my invention, and wish to secure by letters patent, is the destroying of the adhesive property not only of the surface of caoutchouc, gum elastic, or India rubber, but also to a considerable extent below the surface, whether the same be in sheets unconnected with cloth, or other substances, or when used as a coating therefor, by the application thereto of an acid solution of the metals, substantially in the manner set forth.

I also claim the manner of preparing and incorporating lime with the caoutchouc paste, for the purpose of bleaching it, and giving to the sheets formed of it a colour and texture adapting it to receive printed impressions, and rendering it applicable to various other purposes, either without or with the treatment by the metallic solutions, as herein set forth.

I further claim, as an entirely new manufacture, the sheet caoutchouc prepared by the within described process of treatment by the metallic solutions, as herein described; as it is thereby so essentially changed in its properties as to bear but little resemblance to such articles as have, heretofore, been manufactured out of the same material, and is rendered applicable to a variety of new purposes hitherto unattempted, or attempted without success.

CHARLES GOODYEAR.

## Progress of Practical and Theoretical Mechanics and Chemistry.

### *Alexander's Electric Telegraph.**

A model to illustrate the nature and powers of this machine, was exhibited on Wednesday evening at the Society of Arts in Edinburgh. The model consists of a wooden chest about five feet long, three feet wide, three feet deep at the one end, and one foot at the other. The width and depth in this model are those which would probably be found suitable in a working machine; but it will be understood that the length of the machine may be a hundred or a thousand miles, and is limited to five feet in the model merely for convenience. Thirty copper wires extend from end to end of the chest, and are kept apart from each other. At one end (which, for distinction's sake, we shall call the *south* end) they are fastened to a horizontal line of wooden keys, precisely similar to those of a piano forte; at the other, or *north* end, they terminate close to thirty small apertures equally distributed in six rows of five each, over a screen of three feet square which forms the end of the chest. Under these apertures on the outside, are painted in black paint upon a white ground, the twenty-six letters of the alphabet, with the necessary points, the colon, semicolon, and full point, and an asterisk to denote the termination of a word. The letters occupy spaces about an inch square. The wooden keys at the other end have also the letters of the alphabet painted on them in the usual order. The wires serve merely for communication, and we shall now describe the apparatus by which they work.

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*Vide Report of the Committee on Professor Morse's Telegraph, page 106.

This consists at the south end of a pair of plates, zinc and copper, forming a galvanic trough, placed under the keys; and at the *north* end of thirty steel magnets, about four inches long placed close behind the letters painted on the screen. The magnets move horizontally on axes, and are poised within a flat ring of copper wire, formed of the ends of the communicating wires. On their north ends they carry small square bits of black paper, which project in front of the screen, and serve, as *opercula* or *covers* to conceal the letters. When any wire is put in communication with the trough at the south end, the galvanic influence is instantly transmitted to the north end; and in accordance with a well known law discovered by Oersted, the magnet at the end of that wire instantly turns round to the right or left, bearing with it the *operculum* of black paper, and unveiling a letter. When the key, A, for instance, is pressed down with the finger at the south end, the wire attached to it is immediately put in communication with the trough; and at the same instant the letter A at the north end is unveiled, by the magnet turning to the right, and withdrawing the *operculum.* When the finger is removed from the key, it springs back to its place: the communication with the trough ceases; the magnet resumes its position, and the letter is again covered.

Thus by pressing down with the finger, in succession, the keys corresponding to any word or name, we have the letters forming that word or name exhibited at the other end—the name Victoria, for instance, which was the maiden effort of the telegraph on Wednesday evening. In the same way, we may transmit a communication of any length, using an asterisk or cross, to mark the division of one word from another, and the comma, semicolon, or full point, to mark the breaks in a sentence, or its close. No proper experiment was made while we were present, to determine the time necessary for this species of communication; but we have reason to believe, that the letters might be exhibited almost as rapidly as a compositor could set them up in types. Even one-half or one-third of this speed, however, would answer perfectly well.

Galvanism, it is well known, requires a complete circuit for its operation. You must not only carry a wire to the place you mean to communicate with; but you must bring it back again to the trough. Aware of this, our first impression was, that each letter and mark would require two wires, and the machine in these circumstances having sixty wires instead of thirty, its bulk and the complication of its parts would have been much increased. This difficulty has been obviated, however, by a simple and happy contrivance. Instead of the *return* wires extending from the magnet back to the keys, they are cut short at the distance of three inches from the magnet, and all join a transverse copper rod, from which a single wire passes back to the trough, and serves for the whole letters. The telegraph, in this way, requires only thirty-one wires. We may also mention, that the communication between the keys and the trough is made by a long narrow basin, filled with mercury, into which the end of the wire is plunged when the key is pressed down with the finger.

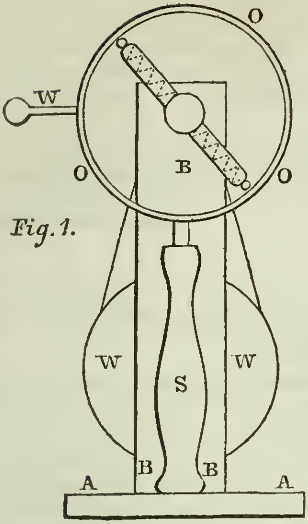
The telegraph, thus constructed, operates with ease and accuracy, as many gentlemen can witness. The term *model*, which we have employed, is in some respects a misnomer. It is the actual machine, with all its essential parts, and merely circumscribed as to *length* by the necessity of keeping it in a room of limited dimensions. While many are laying claim to the invention, to Mr. Alexander belongs the honour of first following out the principle into all its details, meeting every difficulty, completing a definite plan, and showing it in operation. About twenty gentlemen, including some of the most eminent men of science in Edinburgh, have subscribed a memorial stating their high opinion of the merits of the invention, and expressing their readiness to act as a committee for conducting experiments upon a greater scale, in order fully to test its practicability. This ought to be a public concern. A machine which would repeat in Edinburgh words spoken in London, three or four minutes after they were uttered, and continue the communication for any length of time, by night or by day, and with the rapidity which has been described—such a machine reveals a new power, whose stupendous effects upon society no effort of the most vigorous imagination can anticipate.—*Scotsman.* Lond. Mec. Mag.

### *Brilliant Electrical Experiments, well calculated for the Lecture Table.*

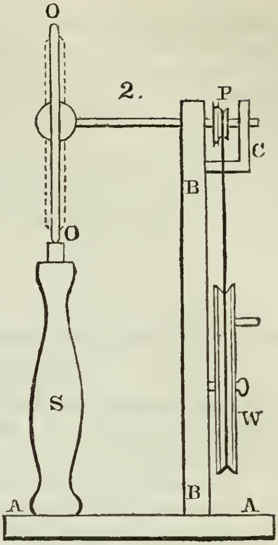
The first of these experiments which we shall describe is made by the electrical machine and the apparatus represented in figs. 1 and 2, the former being a front, and the latter a side elevation.

A A is a stout rectangular mahogany board, which is the base of the instrument. B B B is a vertical piece of similar board, the lower end of which is firmly fixed in the base. Near to the upper end of this vertical piece is a crutch C, fig. 2, which, together with the main upright B B carry a spindle with its pully P. The spindle and pulley are put into rotatory motion by means of the wheel W W, and its band. The farther end of the spindle terminates in a hollow brass ball, into the opposite sides of which, and at right angles to the axis of the spindle are cemented two glass tubes spirally spotted with tin foil as seen in fig. 1. The outer end of each tube terminates with a small brass ball. By this arrangement the spotted tubes can be put into rapid rotation in a vertical plane. S is a glass pillar surmounted by a brass socket terminating upwards in a screw. On this pillar is screwed the ring o, o, o, made of stout brass wire. The inner diameter of the ring must be a little greater than the distance between the outer surfaces of the balls terminating the spotted tubes, in order that the latter may rotate within the ring without touching.

*Fig.1.*



2.



The axis of motion is in the centre of the ring and perpendicular to its plane. A horizontal wire *w*, terminating with a brass ball is screwed to, and projects from, one side of the ring.

When an experiment is to be made with this apparatus, the ball *w*, is to be brought close to the farthest extremity of the prime conductor of an electrical machine, in good order; or to a ball proceeding from the conductor: and in this position the base-board is to be screwed firmly to the table, in the usual way, with clamps.

When the machine is at work, sparks will pass from the prime conductor to the ball *w*; and again from the inner side of the ring to one or both of the spotted tubes, which will thus be brilliantly illuminated, especially if the spindle be touched with the hand, or connected with the cushion by a copper wire. Let now the wheel W W be gently turned; the spotted tubes will still be illuminated; but instead of showing stationary spiral lines of fire, they will now exhibit the most pleasing spectacle ever beheld in the whole range of electrical illuminations, whose fantastic forms will undergo a variety of changes with the speed of the wheel; and when the velocity is considerable, the optical illusion creates ideas of a complete disc of electrical light.

This splendid experiment is susceptible of much pleasing variation. If instead of having the tubes cemented into the central revolving ball they be fastened to it with screws, in the usual way of screwing balls on the extremities of wires; they may easily be removed and replaced by other devices, such as tubes of coloured glass spotted in the same manner: or by slabs of plate glass, spangled in the usual way and varnished with different colours. In this way a disc of any coloured light may be exhibited; or the luminous disc may be composed of concentric annular portions, each of a different colour. If, for instance, the faces of two revolving slabs of glass were each divided into three equal portions by lines perpendicular to their edges, and that the inner portion be varnished yellow, the middle red, and the outer portion blue, each portion could form an annulus of its own colour, and the whole would fill up the whole disc. In all experiments with this apparatus, however, the disc, whatever colour or colours it may exhibit, will necessarily appear annular, because of the central brass ball; which, in a darkened room, is a complete black speck.

By this apparatus, differently coloured pieces of glass may be made to combine the light they transmit; and the composition of colours displayed in the most splendid manner.

Sturgeon's Annals of Electricity.

### *Description of an Economical and powerful sustaining battery.* George H. Baohhoffner.

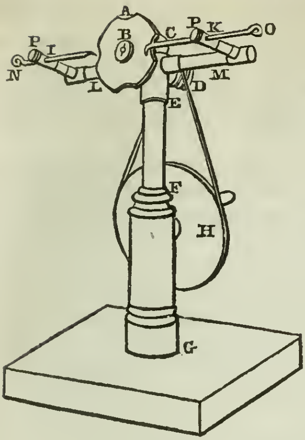
A piece of thin sheet copper is coiled up into the form of a cylinder, and retained in that position by fine copper wire. The size I usually employ is that of 4 inches by 2½; it is then to be placed in a small bladder, which is secured round the same by pack thread, leaving the top open, the membrane forming the bottom of the cylinder; a piece of zinc is coiled up in a similar manner, having previously soldered a copper wire to each, to form the connexion, and the battery is completed. To excite it, place it in any convenient vessel; I usually employ a jelly-pot, and pour into the copper cylinder a saturated solution of the sulphate or any other salt of copper, and outside the same and in contact with the zinc, must be placed another solution, it matters but little of what nature: one of common salt I find to be as good as any that I have tried, and it has the advantage of being always at hand and costs but little, the latter appearing to act as a conductor only; if the battery is required to be kept in action for two or three days, a few crystals of the salt of copper must be placed in the solution of the same.

From this rough statement, it is evident how cheaply an efficient battery may be obtained, and at how little cost it may be repaired when the zinc is destroyed. With an arrangement of six of these batteries, water is rapidly decomposed, metallic wires fused, and brilliant combustion of the charcoal points is obtained.

Ibid.

### *A Galvanic Shock-multiplier, by the* Rev. N. S. Heineken.

A is a thin wheel of copper having four or more circular indentations at equal distances in its circumference. It is fastened by a nut at B to a spindle which passes through the brass tube C, and has at its other end a pulley D. The tube is insulated by means of the glass pillar E F, fixed into the wooden support F G, and by this attached to the base. H is a wheel by turning which the pulley D and disc A revolve. I K two brass arms attached by mountings to glass tubes at L and M, and by them insulated and fixed also to C E. These two brass arms hold the copper wires N O by means of the screws P P. The wire N has its end formed into a slight spring, so also has O. That at N touches the



copper disk A only where the circumference is entire; that at O always presses lightly on the face of the disk. The mode of operation of the apparatus will be sufficiently obvious. If a wire having a moist sponge be attached to one extremity, while the other is connected with one of the poles of a battery, and the hand grasp the moist sponge, and if the other pole of the battery be connected by a wire with N, the other hand grasping a second sponge, and connected with the wire O, a rapid succession of shocks will of course be experienced during the revolution of the disk A, in consequence of the interruptions which are occasioned in the circuit by the indentations in its circumference. The application of the instrument in various experiments, particularly those on the dead body, will be readily suggested.

I will not trespass further on your space than to state that the figure is in size one third of that of the instrument; that the copper disk and wires are amalgamated to ensure good contact; and that by a little alteration the apparatus may be employed for the rapid changing of the poles of a battery in electro-magnetic operations.

Lond. & Edin. Philos. Mag.

## *Friction of the Air.—Spinning of a top.*

Mr. R. Roberts, of Manchester, stated at the British Association, that in 1824 he contrived a machine to enable him to ascertain the amount of friction, but without reference to the resistance of the atmosphere, and he found that as the velocity increased the friction rather diminished. He was convinced, however, that the resistance of the atmosphere should be taken into consideration, and in proof, he stated that on one occasion, he was on the Manchester Railway in a hurricane, blowing in the direction of the railway, and so violent, that the power of the wind was sufficient to move the carriage even without steam. In this way he passed on at such a speed as to completely neutralize the effect of the hurricane—the effect generally was that of a calm. The observation of the President on the pendulums of astronomical clocks, reminded him of a curious circumstance which had come, some years since, under his observation, and was another proof of the resistance offered, under certain circumstances, by the air. Having made a top, which spun for forty-three minutes, he was requested to make another for a friend—this he did, and to give it a handsome appearance he had it lacquered, and then found it would spin only seventeen minutes; he accordingly removed the lacquer, and it then spun for thirty-seven minutes.—Mr. Hawkins, in confirmation, observed, that inconvenience having been experienced from the resistance of the air on a fly wheel, he had greatly diminished it by reducing the surface of the revolving bodies.—Mr. Hardman Earle said, he remembered, that during Dr. Lardner's experiments, at one or more of which he was present, the steam was blown off, and he mentioned several facts, showing the great irregularity in the performance of the same engine under circumstances apparently similar.—Dr. Lardner remarked, in conclusion, that he was convinced that the amount of friction could not be much greater than that now deduced, since the adhesion was found to be within a very small fraction of the theoretical adhesion.

Mr. Hawkins mentioned, at the British Association, that in the same individual there was frequently a great difference between the left and right eye; he knew a case where the focus of one eye was thirty-six inches, and that of the other only three.

Dr. Lardner corroborated Mr. Hawkin's statements, and gave the instance of Professor Airy, who had found that he was differently shortsighted in different directions; in fact, that his eye partook of the character of a spheroid, not of a sphere, and he accordingly got glasses ground on a spheroid, which perfectly suited him. Lond. Mec. Mag.

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## *Browning Gun Barrels.*

Mr. Ettrick submitted to the Section of the British Association, a paper on browning gun barrels. After various experiments, Mr. Ettrick discovered that the process consisted wholly in procuring a *permanent* peroxide of iron, and then colouring such oxide. He had procured not only all shades of brown, but a perfect black, by mixing 1 part of nitric acid with 100 parts of water, and applying this to the barrel with a rag moistened with it. It is material that the rag should be only so much wetted as to damp the iron, for if the fluid be allowed to stream the oxidation will be unequally performed. It is also material that the barrel should be well smoothed and polished, and all greasiness removed by chalk before the browning commences, otherwise a bright brown is not attainable. The barrel, after being wet, should be placed for an hour or more in a window on which the sun shines, and when this process has been thrice repeated, the superfluous rust must be removed by a scratch brush consisting of a quantity of fine iron wire tied up into a bundle. This process being repeated eight or ten times, the barrel will have acquired as good a brown as it frequently receives from the common gunsmiths; but to do away with the disagreeable rusty appearance, it is necessary to proceed to colour the oxide, which Mr. Ettrick accomplishes by dissolving one grain of nitrate of silver in 500 of water, and applying this solution like the browning liquid. The number of repetitions of the nitrate of silver water would depend on the shade of brown required, but Mr. Ettrick found from one to five or six amply sufficient. The barrel is to be placed in the sunshine to obtain a dark colour. The last process was to apply the scratch brush freely, though lightly, and then polish the whole by bees' wax. Mr. Ettrick had, since the date of his own invention, discovered the process used by workmen generally, and long kept secret, but by the plan described, a much finer brown is attainable than that gained by the trade.

Lond. Mech. Mag.

## EXTRACTS FROM FRENCH JOURNALS. TRANSLATED FOR THIS JOURNAL BY J. GRISCOM.

*Discovery of Arsenic in a human body, taken up three years and a half after burial.* By OSSIAN HENRY, Chemical operator of the Royal Academy of Medicine.

The body of a woman which had been buried at the town of Sens three years and a half, was taken up in consequence of renewed suspicion that she had been poisoned by Arsenic. The exhumation was performed with due formality, the head and limbs were removed and the trunk was encased, legally sealed, and sent to Paris for examination. On being opened the body was found to be in perfect preservation, which was ascribed to the dry sandy soil in which it had been buried. A slight odour of rotten wood, owing to pieces of the coffin which accompanied it, was the only perceptible effluvium, while the brown bistre colour of the skin gave it the appearance of a mummy. The viscera had become hardened or corneous, and were so condensed and confounded into a membranous leafy mass as to be scarcely distinguishable from each other. The liver was sufficiently distinct; it had a waxy consistence and a deep brown colour. After a due anatomical examination, the mass of vessels was taken out, freed from the brown sandy powder dispersed through it, and the trunk was returned to Sens to be replaced in the grave.

Although the death was imputed to an arsenical compound, nothing was omitted relative to the presence of other poisons; but the result of this enquiry being completely negative, the attention of the operators was confined to the evidence of the presence of arsenic.

The detached mass was divided very carefully by a scalpel into fine shreds or strips;—these were boiled during an hour, in two successive portions of distilled water, each acidulated by half an ounce of very pure hydrochloric acid, in order to promote the solubility of the arsenite or arseniate of lime which the body might contain, in consequence of the reaction, which had supervened during the long time in which it had been in the ground. The boiled mass was thrown upon a filter of clean linen, and the brown liquid thus obtained, was exposed to the air until the next day. It was then found to be covered with a pretty thick scum of solid fat which was very easily separated.

The clear, brownish, acid fluid, thus obtained, was partly neutralized by pure ammonia, and a current of very pure hydrosulphuric acid was directed through it and kept up for a long time. The gas very soon gave rise to an abundant production of brownish magma, which in the course of forty-eight hours, was completely precipitated. The clear fluid, which was easily decanted from it, gave by analysis nothing more than a small portion of salts of no importance, some phosphate of lime, and a peculiar brown animal matter.

The precipitate was collected upon filtering paper (previously purified by hydrochloric acid and distilled water) and washed with care. In it was to be found the arsenic if any existed, in the form of sulphuret. To clear the precipitate of the brown matter, it was treated repeatedly with very dilute ammonia; but the whole of it being thus dissolved, the new liquid product, of a brown colour, was evaporated to dryness by a heat cautiously regulated. The residue was a dark brown, dry, friable substance, which, put upon charcoal, gave out an empyreumatic, animal odour, which was followed by the smell of garlic, decidedly manifest.

The dry substance being separated into two equal parts, one of them, A, was triturated with alcoholised potash and carefully dried until it became pulverulent. Mixed with black flux and exposed to the blow pipe in a narrow tube, thick, fuliginous, empyreumatic vapours were given off, and a volatile product gathered in the narrow part of the tube, forming a shining metallic ring of a steel grey, and which proved to be metallic arsenic.

The other part of the brown product was mixed with pure nitrate of potassa and strongly calcined in a new porcelain capsule, until the white residue was entirely deprived of animal matter. This was dissolved in distilled water and exactly neutralized by very pure nitric acid. The test of nitrate of silver, then threw down a very abundant *precipitate of a brick red colour*, consisting of *arseniate of silver.*

This salt, washed and dried, produced with the blow pipe and black flux as in the former case, a reflective ring of metallic arsenic. The product of these two processes amounted to seven or eight grains of the metal.

That nothing might be neglected to prove the existence of the poison, we placed a quantity of it in a long open tube, and holding it slightly inclined over a lamp, the metal was speedily oxidised by contact with the air, and yielded a white lameller crystallization. This was boiled in distilled water and the solution was precipitated.

1. Yellow,—by nitrate of silver.
2. Green,—by ammoniacal sulphate of copper.
3. In Yellow flocculi, soluble in ammonia, by sulphuretted hydrogen.

All doubt is thus removed of the existence of arsenic in this body, and that it was to this substance that the death of the individual must be ascribed. In publishing the account, we do not pretend to exhibit a peculiar case, but from the very considerable portion of the poison which we were able to separate, it was thought there might be some benefit in making it known. The example confirms those previously established, and it may afford consolation to humanity, by proving that criminals are not sure of impunity because the earth has for a long time concealed their victims.

Jour. Pharmacie 1837.

*Note by the Translator.*—The results of the analysis described in the foregoing paper, are perfectly satisfactory as it respects the evidence of the existence of arsenic. Had the experimenter been aware of the method of detection by means of the simple and elegant little apparatus, described by James Marsh (Vide Jour. Frank. Inst. Vol. XVIII, p. 338) they might easily have given an additional proof of the presence of the metal. This method removes also one source of doubt which sometimes arises from the carbonaceous matter contained in the flux, which may of itself produce a ring in the tube which has much the appearance of a metallic surface, though it consists only of shining charcoal. The very small quantity of material, which this little instrument will operate upon, as well of metal which it will detect, is another strong recommendation to its adoption. We would propose, in the use of it, the substitution of a small plate of clear mica in lieu of the glass, which, as the author admits, often breaks with the heat.

### *Recipe for an Alloy in imitation of Gold.*

An alloy is made in Germany, (Munich,) of zinc and copper, called *Chrysorin*, on account of its perfect resemblance to gold of twenty carats. This quality depends on its containing the exact proportion of fifty-one parts of zinc, to one hundred parts of copper; for if, by a heat too powerful or too long continued, a portion of the zinc becomes volatilised, nothing but common brass is produced, without lustre, containing fifty parts of zinc and one hundred of copper. The greatest precautions therefore are requisite in the fusion of the two metals. They begin by putting into the bottom of the crucible one-third of the requisite quantity of zinc, and over it all the copper which is covered with a vitreous flux. This is heated in an air furnace until the copper is well melted, which is known by its assuming a mirror-like surface under the flux. The rest of the zinc is then added in small pieces.

Jour. de Connais. Usuelles.

### *On the various uses of Steatite.*

Steatite is a kind of soapy marl, or talc, sometimes white, at others green, or grey, and more rarely red or yellow. Its sp. grav. is from 2.60 to 2.66. It is composed of silex, alumine, magnesia, oxide of iron and water, but it varies in different localities. It is very common in Germany, in Cornwall, and it exists also in the western part of France. As it requires a very high heat for fusion, and is cut or wrought with great facility, very good crucibles can be made of it, which fire hardens and litharge penetrates very easily. It is employed for moulds in metallic castings. It is used in England in the manufactory of porcelain. M. Vilcot of Leige, has made a great number of trials to ascertain whether this substance can be employed by Lapidaries; he has made Cameos of it, to which he has given a fine brilliancy by heat, and such a degree of hardness as to give sparks, with steel. He has succeeded in colouring them yellow, grey, and milk white, by the addition of various solutions. By polishing them on stone, he has given them all the splendour of agate, and has obtained some pieces which resembled onyx, but the fire very soon obliterates the veins, which cannot be reproduced. Having a great affinity for glass, steatite, reduced to very fine powder, answers very well when mixed with other colours, for painting on glass. It is used also as a kind of sympathetic pencil for writing on glass, leaving no traces when the glass is rubbed with woollen cloth, but becoming again visible by breathing freely upon it, and disappearing again as the glass becomes dry. Workers and embroiderers of silk prefer it to chalk for tracing, because it is more durable and does not affect the colours of the stuff. As steatite has the property of uniting with oils and fatty substances, it enters principally into the composition of the balls used for cleaning silk and woollen stuffs. It is the basis also of some pigments. It gives a fine brilliancy to marble, to serpentine and gypseous stones. Mixed with oil, it is used to polish glass and metallic mirrors. If newly prepared leather be powdered with it and allowed to dry, it gives it, when rubbed with horn, a very fine lustre. Steatite is employed for glazing paper, by being spread over it in very fine powder, or better by being mixed with the colouring matter, and then glazing by rubbing with a brush. The powder of steatite, from its unctuosity is one of the substances which give the easiest play to vices and screws, and diminish friction in wheels. Mixed with tallow it furnishes a very favorable material for preserving machinery.

Steatite is easily cut with a saw, turned in a lathe, and smoothed with a plane. It may therefore be worked into any shape, and afterwards if necessary be rendered very hard. When the artist has finished his design he places it in a covered crucible, surrounds the crucible with charcoal in a furnace, raises the heat gradually, keeps it for two or three hours in nearly a white heat and allows it to cool slowly, When it comes out, it is so hard as to strike fire with steel and to blunt the best files.

White specimens of steatite acquire a milk white by exposure to heat; those which are coloured assume a grey or reddish tint, but they may be variously coloured by the aid of oily, alcoholic, acid or alkaline solutions. Colours that dissolve in amber varnish, such as verdigrise, ochre, &c., colour steatite, when heated by charcoal. Colours dissolved in spirits of turpentine are the most lively. Solutions of carthamus (saffron flower) gamboge, campeachy wood, dragons blood, &c., in spirits of wine, colour steatite by steeping it in them several hours. Solution of gold in aqua regia, gives a purple colour, of a shade depending on its strength. Muriate of silver colours it black when aided by sulphuric acid. Sulphate of indigo—a greyish blue. If steatites, coloured by nitro-muriate of gold, or muriate of silver, be exposed to a bright flame, it assumes the metallic colour of gold or silver.

When the stone is heated, colours dissolved in acids are rapidly and finely attached to it, and hence a cameo ground, of any particular colour, is easily obtained. Sulphuric acid produces more effect than nitric and muriatic. Oxalic acid may be successfully employed. Colours dissolved by alkalies, and especially indigo, serve to colour steatite. In general these colours penetrate about one eighth of a line into the body of the stone. We are indebted to M. Moy for these researches.

When the stone is baked, it is polished, as usual, with emery, tripoli, or tin putty. It acquires much brilliancy, resembling agate, jasper, calcedony, &c. It is easy from these facts to infer, that the engraver may avail himself of this substance, on account of its softness, since he may perform upon it in one day as much as he could do upon hard stones in a week; and when it has passed through the fire, his work acquires a hardness and durability almost unlimited.

Jour. des Conn. Usuelles.

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### *On the Constructions of Panoramas.*

Panoramas, invented by Robert Fulton, have undergone numerous modifications, especially in France, by the invention of the diorama and neorama.

The problem consists in making a cylindrical picture, with a circular base, on which all the objects which the artist can discover, from the point of view that he has selected, may be painted in due perspective. The great art is afterwards to enlighten and animate them with the most appropriate colours.

For this purpose a rotunda is constructed exactly circular, fifty-eight feet in diameter, and twenty-three in height. The interior of the walls is hung with cloth regularly stretched over it. After giving the cloth a ground or priming, as in common pictures, there is traced upon it a number of squares, corresponding to those on a sketch previously drawn on paper, whose dimensions are as one to twelve. These sketches are transferred to the cloth, square by square, and are finished in oil or water colours, at the pleasure of the artist.

The spectators are placed on an amphitheatre, erected in the middle of the rotunda, which is ascended by a winding staircase. The height of it is such that the eye of the observer is on a level with the horizon of the picture. An iron gallery, concentric with the rotunda, circumscribes the space from which the picture is seen. The spectator in this gallery is prevented, by the edge of the amphitheatre, and a curtain which hangs from the platform, from seeing either the base or the height of the picture, which allows his imagination to indulge the idea of an immense and indefinite height and depth. This is aided by the change of aspect which he finds in going from the centre towards the gallery. The illusion is so complete that he really fancies himself transported to the very spot which the artist chose for taking his perspective. Idem.

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### *Machine for Washing Potatoes.*

This machine is a cylinder composed of wooden rods, or rounds, fastened at the ends in circular boards. Six of these are put together so as to make a door on one side of the cylinder for putting in and letting out the potatoes. This cylinder is placed in a trough full of water, and is turned by a crank outside. It is raised out of the water by two pullies attached to its axis. The potatoes rubbing against each other and against the rods, are washed and cleaned, the dirt falling into the water of the trough.

This simple machine is very effectual, washing potatoes without allowing them time to become swelled by absorbing the water. Ibid.

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### *New substitute for Bell Glasses.*

I have used for several years, for melons and other delicate plants, bells constructed as follows.

On a wooden hoop, fifteen or eighteen inches in diameter, I erect three segments of circles so as to form a kind of dome twelve or thirteen inches high. I paste on this frame pieces of muslin cut to fit, and give to the bell three coats of varnish made of Cheese curd . 4 ounces.
Slaked lime . . 1 drachm.
Mixed thoroughly, and add Linseed oil . 4 ounces.
The oil easily combines with the mixture, into which is afterwards incorporated whites of eggs and water, each four ounces. This varnish dries quickly. The oil prevents it from scaling, and gives to the cloth the requisite flexibility.

Plants raised under these covers enjoy a more uniform temperature than under glass. The heat is not so great in the middle of the day, but it does not fall so low in the night. The dimensions may be altered at pleasure.

Bodin de la Pichonnerie, Docteur.

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### *Method of preserving Apartments from the Odours of a Kitchen.*

Where kitchens are situated beneath a parlour or sitting room, or even on the same floor, the vapours are sometimes a nuisance. To remedy this inconvenience, a ventillator should be opened into the flue of the kitchen chimney, near the ceiling. The draught of the chimney carries up the effluvia; or if the flue be too wide, a pipe may be attached to the opening, and carried to the top of the chimney. Ibid.

We have known, in the crowded part of a city, an odour from a neighbouring apartment, more intolerable than that from a kitchen, effectually removed by a pipe passed into the flue of a chimney.

The gas from a coal grate sometimes, on reaching the top of the chimney, falls by its superior gravity into an adjoining flue, and thence into a chamber below, where it becomes very noxious. We were informed by Dr. Hare, that, on one occasion, suspecting this to be the source of the annoyance in one of the chambers of his own house, be had an opening made in the side of the chimney above the roof, and a little below the top of the stack. Through this opening the gas then flowed without reaching the top, which completely remedied the difficulty. Tr.

### *To preserve Water in Casks at Sea, and in Cisterns.*

Add a little black oxide of manganese in powder to the water, and agitate the mixture. The water on this addition loses its bad taste, and may be preserved indefinitely. Ibid.

### *Fresh Jelly for the Sick.*

The difficulty of procuring recently prepared jelly, except at a very high price, and from known confectioners, may render the following acceptable to some persons in ill health. Take the half of a young and thin fowl, a quarter of a pound of knuckle of veal, and a quart of water. Put the materials in a glazed earthen pot, over a slow fire or hot ashes, and let them concoct eight hours until the fluid is reduced to less than a pint. Strain it through a fine sieve, pour the liquid into coffee cups and set them aside in a cool place. In a few hours a firm jelly of good consistence will be found. A carrot, turnip, parsnip, two beets and one half of a roasted onion, or any of those at pleasure, with a due quantity of salt, may be added to the materials before they are placed on the fire. Ibid.

### *On the Light obtained from Air and Oxygen, by Compression.* By M. Thenard.

The author ascertained that chemists had erred in supposing that all bodies, and even gases, became luminous by a strong and sudden compression.

M. Saissy concluded from his experiments, that oxygen when compressed gave out a bright light; air produced light, but less brilliant, but that no light whatever could be obtained by compressing either azote, hydrogen or carbonic acid.

M. Thenard, in prosecuting the examination, soon learned that the property of becoming luminous in the dark by compression, belongs in reality only to oxygen, to air, and to chlorine; but reflecting afterwards that the pistons used to compress the gases in the tubes consisted in part of leather impregnated with some greasy substance, which water moistens with difficulty, he thought that the light which appeared might proceed only from the sudden production of a little water, or hydro-chloric acid. To determine this, he had pistons prepared of hatters' felt, or, if of leather, to the latter was attached a cylinder of metal so as to cut off all communication between the leather and the gas, except in an extremely small space. The tubes were accurately ground.

Thus arranged, when care was taken not to moisten the felt or the metallic cylinder, and to clean the tube with potash, there never was any light produced; but if the felt was moist, or the tube badly cleaned, a light almost always appeared.

It was found also that in oxygen gas, with the piston moistened, inflammation took place not only in amadou, but in paper, wood, and even box wood, when perfectly dry. When impregnated with oil, they took fire more easily.

Similar trials were made with chlorine. When the paper was impregnated with very little oil, it became incandescent. Alone, neither paper nor wood succeeded, the action being either too weak or too slow.

It was found impracticable to inflame a piece of pine wood in oxygen gas at the temperature of 350° under atmospheric pressure alone; but it was inflamed at 252° under a pressure of 262 centimetres. The pressure was effected by a column of quicksilver in a bent tube, the part containing the fragment of wood being plunged in a basin of mercury placed over a furnace. By employing a small portion of fulminate of mercury, which explodes at 145° C. it was proved that carbonic acid gas had its temperature raised by compression. The powder exploded in carbonic acid, azote, and in hydrogen, at the same temperature as in the air, when heated to the same extent by the compression of the gases. At 205° the glass was blown to pieces by compressing them over the powder.

The principal results of M. Thenard are thus stated:

1. No gas becomes luminous of itself by ordinary compression in a pneumatic fire pump.

2. When a gas is compressed by hand as forcibly as possible in a glass tube, the temperature is raised thereby above 205° Cent. = 400 F. So that powders which decompose only at that temperature, detonate in azote, hydrogen, and carbonic acid subjected to a sudden and forcible compression.

3. Paper and wood are inflamed in oxygen by a strong compression. It is the same with paper in chlorine, when impregnated with a little oil.

4. There is every reason to believe that if gases may become luminous by pressure, it must be only at a very high temperature. Ann. de Chimie.

## Physical Science.

### *On the formation of Hail.* By M. De la Rive.

Electricity, whose presence in the formation of hail is rendered probable by the thunder and lightning which always accompany and characterize storms, has long been regarded as playing an important part in this phenomenon, as in almost all other meteorological occurrences. Volta, especially, by means of the opposite electricities with which he supposed the clouds which were placed the one over the other were charged, explained the augmentation in the size of the hailstones, which, according to him, passed from one of these clouds to the other, as light bodies situated between two jars filled with opposite electricities, would be alternately attracted and repelled between them.

In thus frequently traversing the humid atmosphere which separates the two clouds, and in slightly penetrating the clouds themselves, he maintained that each hailstone condenses upon itself an increasing quantity of water, which is congealed, thus forming the concentric layers which are observed in its structure; till finally becoming too heavy, it could no longer be sustained among the clouds, and fell upon the earth in a more or less inclined direction, according to the strength of the wind. It is to this tossing to and fro between the two clouds, and to the dashing of the hailstones against each other, that he ascribed the peculiar noise which is heard in the air some time previous to the descent of hail, and which has been compared to the noise which the quick and violent shaking of a sack full of nuts would produce. As to the formation of the nucleus of the hailstone, Volta attributed it to the great degree of cold produced by the evaporation which takes place at the upper surface of a cloud, the rapidity of which is increased by the direct effect of the solar rays which strike upon the cloud, and are absorbed by it.

The theory of Volta was attacked in a very powerful manner by M. Arago, in a very interesting article, which appeared in the Annuaire of the Board of Longitude for 1828. After confirming some objections which had previously been advanced by M. Bellani, the illustrious Frenchman suggested many others. How, for example, can it be admitted, that the great evaporation produced by the heating of the cloud by the action of the solar ray can be the real cause of greater cold, when this evaporation takes place only in virtue of the larger quantity of heat which is supplied to the liquid? Who, again, can conceive that the electrical power exercised by bodies so light as the clouds can sustain and neutralize the action of the weight of the hailstones, amounting sometimes to half a pound? or, finally, how can we suppose that two clouds can continue so strongly electrical that they can move heavy masses when they are so near each other, and separated only by an extremely humid stratum, through which the electricity might freely pass from the one cloud to the other?

Such are some of the objections to which the theory of Volta is liable, and which M. Arago points out in the article just referred to. It was the difficulties in which the theory is involved, that led the *Academie des Sciences* in the year 1830, to appoint the best explanation of the phenomena of hail as the subject of the great prize which fell to be delivered in 1832. The conditions on which it was to be conferred were severe. The competitors were to supply a theory supported by direct experiments, and upon varied observations made, if possible, in the very regions in which the hail was formed, and which might replace the vague hypothesis with which we have been compelled to be satisfied up to the present time. The essayists were also recommended to avail themselves of all the accurate information which had hitherto been collected on the radiation of caloric, on the temperature of the atmosphere at different elevations, on the cold produced by evaporation, and upon electricity, &c.; finally, they were required, whilst treating of the formation of hailstones, to follow out the consequences of the theory they should adapt to its numerical applications, regarding the physical constitution of these hailstones, also respecting the enormous bulk they sometimes acquire, and as to the season of the year, and the times of the day in which they were most commonly observed. But in 1832 the prize was not conferred, because none of the memoirs presented were considered worthy of the honour; and the *Academie* again appointed this subject as the question for competition for the year 1834. Again, however, none of the essayists fulfilled the conditions proposed, the prize continued unadjudicated, and from that time, we believe, the subject has been entirely withdrawn.

It is under these circumstances that M. Lecoq, without aiming at the prize, appears to have complied, if not with all, yet, doubtless, with the most difficult of the required conditions; inasmuch as he has produced observations which were made in the very regions in which the hail was formed, and which besides, as we shall presently see, are abundantly calculated to throw light upon the theory of the phenomenon, and especially to demonstrate by facts the truth of the objections previously offered against the theory of Volta. We shall now allow M. Lecoq to speak for himself, and shall then conclude this article by some considerations on the phenomenon of hail, as influenced by electricity.

The year 1835 was quite remarkable for the number and intensity of the storms which prevailed in the south and middle of France. Electrical clouds rested permanently above the high mountains of Auvergne, and if sometimes the heat of the sun succeeded in dissolving them, it was only for a few hours, and very rarely for a whole day. The clouds accumulated with rapidity, the thunder rolled in the distance, a tempest announced the storm, and the rains descended in torrents. Violent hail showers had already destroyed the harvest in the district of the Puy-de-Dome, and every day brought with it fresh disasters.

On the 28th of July the sun rose from an azure sky, no cloud appeared on the horizon, no vapour floated in the atmosphere, so that a beautiful day was anticipated. At 10 A. M. the heat became intense, and at midday it was almost intolerable, and then some thin flakes of vapour floated in the air at a great distance; the wind was north, but so feeble, that it in no degree tempered the heat. At one o'clock the wind had increased; the white and floating clouds had descended considerably, and half an hour later, covered a great part of the horizon; they had a greyish tint, which became darker and darker, till they were nearly quite black. At two o'clock they formed an immense covering over the whole of Auvergne; and it was then easy to anticipate that a frightful storm was at hand. We waited with anxiety for the issue of that majestic and terrible scene which was preparing. Silence and consternation every where reigned, speedily flashes of lightning illuminated the massive vapours which covered the old volcanoes of Auvergne, while the sun still shone upon a portion of La Limagne. We then heard a distant and low-muttering sound which resembled a kind of rolling, and almost at the same time we saw a vast cloud advance from the west to the east, pure white in some places, but principally on its edges, and of a deep grey colour in the centre; it approached with great rapidity, and seemed to be hurried forward by a violent west wind, which we had not previously felt at Clermont. This cloud was evidently underneath all the others; its borders were festooned and deeply slashed, and protuberances, in the shape of long nipples, were suspended from the lower portion. At a quarter past two, the anterior part of this cloud had approached very near to Clermont, and the noise which we had long indistinctly heard, was now very intense; and I then very clearly distinguished a very rapid motion in the edges of the cloud; these edges seemed to me to be undulating, but in the position in which I was, what appeared to be undulations must have been the product of a very violent agitation. I then imagined that I could distinctly perceive hailstones in the edges of the cloud, and I predicted to some persons who were with me the immediate descent of hail. Accordingly, two minutes after having seen this whirlwind kind of motion, there was a fall of hailstones, which instantly broke all the tiles of the houses, and all the panes of glass exposed to the north and west; for the hailstones being at the same time propelled along both by the north and west wind necessarily took the mean direction.

The first hailstones which fell succeeded each other very slowly, then all at once their number increased so rapidly that in ten minutes the soil was covered with them; some drops of water escaped at the same time from the electrical cloud, and then the distant rolling sound which we had so long heard entirely ceased; and the cloud freed from its swelling appendages, was carried away by the wind; after some hours the sun illuminated, with its pale and feeble light, that scene of desolation which night was speedily about to envelope.

It is not necessary that I should describe in detail the terrible effects of these hailstones. Suffice it to say, that some branches of trees two inches in diameter were cut asunder by them; some polished stones which formed part of the cornice of houses were broken on their edges, and some phonolite slabs, which were employed instead of the tiles which cover the roofs, were broken by the shock of the masses of ice. Finally, a considerable part of the beautifully stained glass in the windows of the cathedral of Clermont was in a few minutes broken, although it had been exposed for at least four centuries without having been injured by any storm.

The hailstones fell very obliquely, so much so, that many persons were struck by them in their rooms, after they had entered, through their windows; others were surprised in the fields and were wounded, though I have not heard that any were killed. I anticipated that I should have discovered a marked rotary motion in the hailstones, but I could not convince myself of it at the moment of their fall, for they almost all broke instantly on the pavement.

The fall of the hail was scarcely over when I went, accompanied by M. Bouillet into the Botanic Garden, with the intention of examining the hailstones. Here we found many which, from having fallen upon the plants, were quite entire, and presented very remarkable forms. Their medium size was about the size of a pullet's egg, and some were as large as a turkey's. We were, however, informed that some of larger dimensions had fallen at Montferrand. Their form was an elongated spheroid, with the two extremities apparently equal: they were generally studded over with crystals, some of which still bore the shape of hexagonal prisms, terminated by six-sided prisms; but more frequently the angles had melted away, and the prisms had become cylindrical. Some of these superadded crystals projected as much as eighteen lines at the moment of their fall, and some according to appearance were two inches high. Other hailstones were only rough on their surface, and presented an infinite number of small elevations, like the masses of sulphuretted iron which are found in certain clays and lignites.

The crystals were grouped at the two extremities of the great axis of the ellipsoid, which, to all appearance, were the two poles of the hailstones, and their equator, so to speak, was deprived of a large proportion of them: in all, the crystals were largest at the two extremities. The interior structure of the hailstones was nearly always the same. The centre was formed of small grains of white hoar-frost, and was opaque and fibrous; this was surrounded by many layers of transparent ice, which were sometimes so distinct that they could be counted; they increased in thickness as they approached the circumference, and they appeared harder towards the exterior than in the interior.

Their weight was not great, for the heaviest we weighed was only four ounces. However it is probable that the heaviest did not fall within our observation, for other individuals found some of them as heavy as five ounces and a half; and I have been assured that some weighed as much as eight ounces, and even as several pounds. Laying aside all exaggeration, I am inclined to believe that some amounted to eight ounces, though I much doubt if any were heavier.

Painfully distressed with the disastrous consequences of the storm, the opportunity escaped me of collecting the hail stones and afterwards analyzing the water, which I subsequently much regretted, and the more so, as persons worthy of credit have assured me, that many of them deposited a blackish residuum, which had a disagreeable smell, and that the water which was obtained on their melting had a very decided odour.

Having learned that the storm had raged in the Department de la Creuse, I suspected it might have prevailed to a still greater extent, and therefore requested M. Dejean, the Prefect of the Puy-du-Dome, to solicit information from the Prefects of the neighbouring departments, which he did with the greatest kindness.

I thus learned that the storm began at ten o'clock in the morning over the sea; the hail commenced by desolating a part of the Ile-d'Oleron, particularly the communes of St. Pierre and St. George's. The cloud then passed from the west to the east over the department of La Charente Inferieure, in which the district of Marennes particularly suffered. The communes of St. Aynant, St. Jean-d'Angle, St. Symphorien, St. Sornin, St. Just, Arvers, &c., were also visited by the storm, the hailstones varying from the size of a hazel-nut to that of a walnut.

The cloud passed over La Charente without discharging any hail; at least I have not obtained any information that it did from the Prefect of this department; but in Haute-Vienne, and exactly on the confines of La Charente, the hail fell in many places in the neighbourhood of Rochechouart. From thence, and pursuing a straight line from west to east, it crossed the department of Haute-Vienne. At noon it arrived at La Creuse, district of Bourganeuf. The communes of Faux-Mazuras, Manzac, Soubrebord, Morterolle, Vidaillac, St. Hilaire, La Pouge, and St. George's, were more or less invaded by it. The storm continuing to follow the same direction, reached the district of Aubusson, and there produced great devastation. From mid-day till two P. M. enormous hailstones fell in the communes of St. Amand, Lupersat-Ars, St. Avit-le-Pauvre, St. Sulpice-les-Champs, La Rochelle, St. Maixent, St. Ulpimien, Maynat, Beissat, Alleyrat, St. Silvain-Letrueq, St. Aynat, La Chaussade, St. Michel-de-Vesse, Chavanat, Malleret, and Banise. At half past one o'clock the storm reached the western limit of the department of Puy-du-Dome; a quarter of an hour later, there descended upon the communes of Gelles, Proudine, St. P.-le-Chastel, St. Oure et Roure, enormous hailstones which, in a few minutes, covered the earth to the thickness of three inches. At two o'clock, masses of real ice fell upon the lava which extends behind the Puy-du-Dome, and were broken to pieces on the angles of the volcanic rocks. Shortly after the cloud passed the Puy-du-Dome, it did much damage in the commune of Arcines, and from about a quarter till half past two, it finished its disastrous course, upon Clermont and Montferrand; and thus in about four hours and a half the tempest cloud traversed a space of about ninety leagues.

In La Charente Inferieure, some communes of the district of Jonsac were visited by hail showers between three and four o'clock P. M., as some others had been at four o'clock A. M. At St. Yrieix (Haute-Vienne) there was also a fall of hail between three and four o'clock P. M.; and finally, half an hour later than that at Clermont, in the same department, the storm descended upon the communes of St. Germain, L'Embron, Ardes, St. Gervais, Collonges, Mauriat, Beaulieu, Lebrénil, Jumeaux, Auzatsur, Allier, Orsonnette, Lamonge, and Estel.

Hence we may conclude that the line of the hail was accompanied with lateral clouds, which the north wind carried generally to the south. The cloud which carried the hail was at first narrow, it then increased in size, and attained above the department of La Creuse, its greatest width; it then contracted again till it reached the middle of the department of the Puy-du-Dome, in which its extremity, cut in a straight line, presented an edge of half a league in breadth: its shape was that of a spindle, of which each truncated extremity was situated on the one side upon the Ile-d'Oleron, and on the other over Clermont, and the widest part was above La Creuse. In all the more ample accounts I have obtained, it is stated that the colour of the cloud was grey and white; that its edges revolved, that it extended from west to east, and with great rapidity, under the enormous cloud which hid the heavens from every eye. The wind also was every where the same, that is to say, there were two currents, the one placed above the other, which crossed each other at right angles, and in the direction of the four cardinal points, or from north to south, and from west to east.

The intensity of the storm went on steadily increasing. In La Charente Inferieure the hailstones were small, round, and not very numerous; their numbers and volume increased in the department of Haute-Vienne, where some of them assumed the oval form; but it was especially in the department of La Creuse and in the district of Aubusson, that the hailstones attained all their size, and that oval form which they preserved as far as Clermont; and their bulk was, to all appearance, very considerable, for the documents I have received from this department nearly all assign eight or ten ounces to them, and some as much as two and three pounds, so we are safe in concluding, that many of the larger were six or eight ounces.

It appears that the others were not covered with those long crystals which were found in those which fell at Clermont; these latter, during their long course, were the only ones which allowed the water of the cloud which sustained them to crystallize around them.

The hail was every where of short duration, it seldom lasted for half an hour, and almost every where it was followed by rain, which, however, was not very copious.

The tempest cloud was exceedingly low when it left the department of La Creuse, for it passed along below the summit of the Puy-du-Dome, on which no hail fell, whilst a great quantity fell on the Little Puy-du-Dome, at the height of 3700 feet. Several persons who were upon this mountain at the time, were struck by the hailstones without experiencing any injury from them, although they were all studded with long and many pointed crystals. The animals which were feeding at this elevation were also assailed by these hailstones without manifesting any signs of fear, whilst some accidents happened on the road to Limoges, at an elevation of 620 feet less: the horses being hit hard, took fright, and the carriages were overturned.

The hailstones at the top of the Little Puy-du-dome were carried along with great horizontal rapidity, and a few only fell on the summit of the mountain; they passed along with a hissing noise in a stratum of air which was extremely cold.

After the storm, I satisfactorily ascertained the height at which the hail was formed, by an attentive examination of the trees and plants, at the base and on the sides of the Great Puy-du-Dome.

At a certain elevation, the leaves, though exposed to the action of the hailstones, were not much injured, and were in no degree torn; for not having acquired at that time any great vertical velocity, they struck without tearing, and so fell under the trees. Somewhat lower down, descending towards Clermont, the leaves of the trees were lacerated; lower still, the branches were broken, and we have already stated some of the devastations of which Clermont was the scene; for the hailstones had then traversed a vertical course of from 2000 to 2500 feet.

The storm of the 28th July was assuredly one of the most awful that has been witnessed for many years. During the following days numerous very heavy showers were the preludes of new storms; and on the 2d of August a part of the zone which had been destroyed by the hail of the 28th of July, was again whitened with fresh hailstones; but nothing had been left for further destruction.

It happened that on the 2d of August I was a witness, so to speak, of the formation of the storm, and of the congelation of the hailstones.

Leaving Clermont at six in the morning, I ascended the high ground which commands the town on the west. I traced the limits of the hail on the 28th July, that I might determine, by following the edges of the injured surface, the shape of the cloud which had conveyed the dreadful scourge. At 10 I reached the base of the Puy-du-Dome; the day being splendid, and the sun most powerful.

Some white clouds extended themselves over the Mount-Dore; the Puy-du-Dome stood out majestically from the azure sky. Some shepherds whom I had interrogated respecting the effects of the hail on the 28th, urged me to retreat without loss of time to the hamlet of La Barraque, if I wished to avoid the storm which, according to them, was assuredly and speedily coming to assail us. The hope of seeing, in all its details, one of those magnificent scenes of which the atmosphere is the theatre, induced me, on the contrary, to attain, as quickly as possible, the summit of the Puy-du-Dome, and before mid-day I was seated on the top of this enormous pyramid, and extending my observations over the immense horizon. The west wind, which had prevailed all the morning, speedily brought along with it some low clouds, which passed a few yards above my head, but the sun again appeared. I then saw other clouds detach themselves from the Mont-Dore, and approach very near me, impelled by a very violent south wind, but which I did not feel till near one o'clock. When I thus saw great clouds proceeding in different directions, I could not for an instant doubt the formation of hail, and my hopes were soon changed into reality.

So long as the two strata of clouds were not superimposed on each other, there was no appearance of hail. All I noticed was, that those which came from the south, and which were the most elevated, were congregating in little groups, which seemed to precipitate themselves on each other, so forming great black clouds, so large and weighty that the wind could scarcely move them, though they nevertheless proceeded towards the north. The lower part of the cloud would then elongate itself, presenting an enormous projection, torrents of water would speedily escape from it, which inundated spaces which were very circumscribed. As soon as a large quantity of water had escaped from the cloud, it became lighter, was again carried along by the wind, and disappeared at the horizon. This phenomenon was repeated many times during the course of an hour: but by this time the west wind had collected a great number of clouds, which formed an immense curtain, extending over the whole vault of the heavens. The south wind pushed under this stratum of vapour additional white clouds, which came with great velocity. The wind became violent and very cold on the summit of the Puy-du-Dome. The lower stratum of clouds was not like the upper, uniform, but was composed of numerous coloured flocculi, which advanced in the same direction, but at unequal distances, and with different velocities. The brightest flashes of lightning illuminated them from time to time, and the thunderbolts, like furrows of light, passed from one cloud to another; sometimes an extended flash seemed even to traverse, at the same moment, the space which separates the Puy-du-Dome from the Mont-Dore. All these phenomena occurred in the lower strata of vapours, and I never saw the electric spark traverse the stratum of air which separated the two layers of clouds. I perceived the hail in the distance precipitate itself from the lower clouds and fall to the earth; I saw it distinctly at the distance of fifty yards from the summit of the Puy-du-Dome, and before my face. The cloud whence it escaped had indented edges, and exhibited in these edges a whirlwind kind of movement which it is difficult to describe: it seemed as if each hailstone was forced forward by an electric repulsion. Some escaped from beneath, others sprang out from above, so that they flew off in all directions, and would assuredly have reached the earth in many different courses, if the south wind, which was beneath the west wind, had not blown them all towards the north. After five or six minutes of this extraordinary agitation, in which the anterior edges only of the cloud seemed to participate, the hail ceased, order was re-established, the hail cloud, which had continued to advance very rapidly, continued its route towards the north, allowing us to perceive in the distance some sprinklings of rain, which scarcely reached the earth's surface, appearing rather to be dissolved in the lower strata of the atmosphere.

I waited for a second scene similar to that which I have just described, till a prodigious flash of lightning illuminated all the lower mass of clouds, one of whose edges rested upon the summit of the Puy-du-Dome. I imagined that I was all of a sudden plunged into the most vivid light, and experienced a general uneasiness, which probably arose solely from the terror with which I was seized. I descended the Puy-du-Dome with the greatest rapidity, fearing to be hurt by the hailstones, or at least to be drenched by the storm, and I made for an asylum in a hollow grotto at the base of the Puy-du-Dôme, which had on other occasions afforded me shelter. The summit of the Puy-du-Dome was enveloped in the tempest cloud, and it would have been imprudent to have remained longer there.

[TO BE CONTINUED.]

## *Shooting Stars.*

[From the pen of M. Arago, in the Annuaire of 1836.]

If the reader will refer to page 429 of our third volume, he will find a sketch of the first of the appearances here alluded to, with an account of their being seen in the West Indies at the time.

These phenomena, which have often been considered unworthy of investigation, and regarded simply as atmospheric meteors, originating in the inflammation of a quantity of hydrogen gas, have, in consequence of recent observations, become objects of greater attention among men of science. Previous theories limited their place in the heavens to our own atmosphere; but from observations made at Breslau, and other places, by Professor Brandes, and several of his pupils, the height of some shooting stars has been calculated at 500 English miles; and the rate at which they move not less than thirty-six miles in a second, which is nearly double the rate of the earth's motion round the sun. If a reduction be made to one-half of this rate per second, in order to allow for the illusion occasioned by the motion of the earth, the real motion would be eighteen miles per second, which, with the exception of the earth, would still be more rapid than that of any of the principal bodies of our system. In the attempts which have been made to ascertain the apparent direction in which shooting stars usually move, it has been ascertained, that although they become ignited in our atmosphere, they come from beyond it. It is singular that their general direction should be contrary to that in which the earth moves in its annual orbit; and it is much to be desired that the inferences already deduced should be corrected or confirmed by a greater number of observations. We think that the officers of the watch on board the Bonite,* should be invited, during their voyage of discovery, to note the hour of the appearance of each shooting star, its angular height above the horizon, and especially the direction in which it moves. In referring these meteors to the principal stars of the constellations which they traverse, the different questions here raised can be easily settled.

The means of accounting for the extraordinary appearance of luminous projectiles observed in America in the night of November 12th and 13th, 1833, are not very satisfactory, unless it be assumed that, besides the planetary bodies which revolve round the sun, there are myriads of smaller bodies which only become visible at the moment when they come within our atmosphere, and assume a meteoric appearance; that these asteroids (to use the term which Herschel formerly applied to Ceres, Pallas, Juno, and Vesta) move in groups; and that they move singly also. A careful observation of shooting stars is the only means of enlightening us on this curious subject.

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*A French vessel on a voyage of discovery.

The shooting stars in America, to which allusion has been made, were observed in 1833. They succeeded each other at such short intervals that it was impossible to count them; and the most moderate calculations fixed their number at *hundreds of thousands.* They were so numerous, and showed themselves in so many quarters of the heavens at the same time, that the attempts to estimate them were only rough guesses. At the Observatory at Boston, their number was considered to equal one-half of the flakes which fill the air in an ordinary fall of snow. When their numbers were diminishing, 650 stars were counted in fifteen minutes, in a circumscribed part of the heavens, which did not comprise a tenth part of the visible horizon; and these did not amount to more than two-thirds of the whole number seen, which was at least 866; and if the whole hemisphere could have been surveyed by one observer, the number seen would have been 8600, or 36,640 per hour. As the phenomena continued more than seven hours, the number of shooting stars visible at Boston was upwards of 240,000; and it should be recollected that the basis of this calculation was taken when the intensity of the phenomenon was diminishing. It was visible along the whole of the eastern coast of North America, from the Gulf of Mexico to Halifax, from nine o'clock in the evening to sunrise, and in some places in full daylight, at eight o'clock in the morning. All these meteors came from the same point of the heavens, viz. $\gamma$ of Leo; and those which were seen elsewhere were the effect of the earth's movement, which caused an apparent alteration in the position of this star. The above facts are certainly very curious, but the following are not less so:—

The shooting stars observed in the United States appeared in the night of the 12th and 13th of November. In 1799 a similar phenomenon was observed in America by M. de Humboldt, in Greenland by the Moravian Brethren, and in Germany by various individuals; and the period of its appearance was also the night of the 12th and 13th of November. In 1832, in Europe, and some parts of Asia, the phenomenon was witnessed; and the date was still the night of the 12th and 13th of November. This identity of dates induces us to urge upon our young seamen the task of observing with attention the appearances in the firmament between the 10th and 15th of November. Since my report has been read to the Academy, M. Berard, one of the most intelligent officers of the French marine, has favoured me with the subjoined extract from the journal of the brig Loiret, which he commands:—"The 13th of November, 1831, at four o'clock in the morning, the sky being perfectly cloudless, and a copious dew falling, we have seen a number of shooting stars, and luminous meteors of great dimensions. During upwards of three hours, more than two per minute were seen. One of these meteors, which appeared in the zenith, left an immense train from east to west, like a luminous band; and in it many of the colours of the rainbow were distinctly visible: its breadth was equal to one-half of the moon's diameter, and the light which it gave did not disappear for six minutes. We were on the coast of Spain, near Carthagena."

On the 13th of November, 1835, a large and brilliant meteor fell near Belley, in the department of the Ain, and set fire to a farm-yard. In the same night of the 13th of November, a shooting star, larger and more brilliant than Jupiter, was observed at Lille by M. Delezenne. It left on its passage a shower of sparks precisely similar to those which follow a sky-rocket.

The facts we have now given, confirm more and more the existence of a zone composed of myriads of small bodies, whose orbits come within the limits of the earth's ecliptic every year between the 11th and 13th of November. This is a new planetary world which begins to open to us. It is almost unnecessary to state how highly important it is to ascertain if other masses of asteroides do not come within the earth's ecliptic at other points than that which it reaches about the 12th of November. It is desirable to make observations between the 20th and 24th of April, as well as in November; for in 1803, on the 22nd of April, I believe, from one o'clock in the morning until three, shooting stars were seen in all directions in such great numbers in Virginia and Massachusetts as to be compared to a shower of sky-rockets. Messier states that on the 17th of June, 1777, towards noon, he saw, in the space of five minutes, a very large number of black globules pass over the sun's disc. Were not these globules, also, asteroides?

Nautical Magazine.

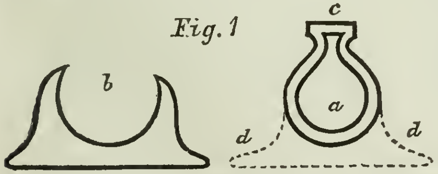
## Progress of Civil Engineering.

### *Ruthven's Improvement on Iron Rails for Railways.*

Mr. Ruthven of Edinburgh has bestowed much time and labour in contriving a form of a rail which, he thinks, will be found to possess material advantage over the wrought iron rails now in use. The subjoined figures represent a section of the rail *(fig.* 1, *a)* and the chair *(b.)*

The rail (*a*) consists of a tube of cast iron, about four or five inches in diameter, and thicker below than above. At top it extends upwards, leaving a flat surface (*c*) for the wheel of the carriage. It is formed in lengths of nine feet, or more, and has a chair, marked by the dotted line *d d*, cast on it at the middle, and, of course, immovable. The chair for joining the ends of two rails is of the form *b*. Its curved interior exceeds a semicircle; so that it embraces and retains the rails without any pins.

*Fig. 1*



The advantages of this invention in Mr. Ruthven's opinion, are the following:—

1. The hollow rail (the bottom of which, it must be remembered, is one half thicker than the sides and top) is much stronger than a solid rail of the same weight and materials. 2. The tubular form is a secu-

rity against its bending laterally outwards or inwards. 3. The joined ends, being embraced within the chair, are more effectually secured from springing up than in the usual way, by pins; while the rail is prevented from rolling in its seat by the fixed chair *d d*. 4. The longitudinal contraction or expansion of the rails, by variations of temperature, is provided for by the absence of the pins, without producing any looseness. 5. He thinks cast-iron might be employed in this way for rails, instead of malleable, with a great saving of expense; and it is allowed, we believe, that, except for its frangibility, cast iron is the preferable material. The form, however, is quite consistent with the use of wrought iron. He has had some lengths of rails cast, and he has found by experiment that a yard of it, weighing 48 lbs., placed with its two ends on rests, supports a weight of more than ten tons.

We think there is merit enough in these rails to deserve a trial, which could be easily made by laying a space of twenty yards with them, in some of the existing railways where locomotive engines are used.

We mentioned some time ago, that Mr. Ruthven was erecting one of Avery's engines (an American invention,) which works by the reaction of steam, without beam, crank, piston, or valve. It is now ready, and will be at work in his own premises as soon as the masonry and external parts are completed.—(*Scotsman*, Aug. 26, 1837.)

The following account of Mr. Ruthven's rails has been addressed by himself to the editor of the *Scotsman;* that intelligent and scientific gentleman having, with his usual attention to every description of improvement, given the notice of it which we have just quoted.

"Having for many years devoted much attention to this important subject, it may be considered as the result of well-matured investigation; and, although it may surprise many that there should be any difficulty in deciding on the best *form* of rail that can be adopted, after the experience had in the various railways established both in Europe and America, yet it appears that much misconception in regard to the proper *form* is still entertained. For instance, the rails on the Liverpool and Manchester Railway, without being greatly varied in form, have been changed in weight from 35lb. to 75lb. a yard. The expense attending such a change need not be stated: this and many others are proof how far the strength and weight of rail have been considered more important than the form.

"It has been supposed that a proper knowledge of the strength of iron was generally possessed, and that nothing more was required but to increase the weight of rails, and the desired object would be attained. It may be demonstrated, however, that *form* is equally important as weight. All admit that a tube is much stronger than the same quantity of material in a solid body. It may also be supposed to be admitted that the rails give resistance to the carriages, or weight, on them, by the tension of the metal on the under side, and compression on the upper. Many interesting experiments have been made to ascertain the relative strength of rails, and compare one kind of iron with another; but this has been done more to ascertain the proportional strength in the difference in the weight of material, than in the variety of form; for a given weight of material appears hitherto to have been more considered than the form.

"I shall now, therefore, call your attention, and that of those connected with this national improvement, to the interesting fact, published in your paper of the 16th inst., as having been stated at the recent meeting of the British Association in Liverpool, by Messrs. Fairbairn and Hodgkinson; viz., 'The next experiment was on castings of a T form, or resembling railway rails, which were broken with the flange both upwards and downwards. In the first experiment, with the flange downwards ⊥, the bar of cold blast iron bore a weight of 1050lb. They then reversed the bar's position, putting the rib downwards T; and the bar broke with a weight of only 266lb.; so that there was a great difference, and this was of great importance in reference to the *shape* of *rails*, beams, &c., for bearing heavy weights.' This is certainly too important to be passed over without particular notice, and is the point to which I wish to call attention. The rail proposed by me is tubular; and, being laid horizontally, increased strength is gained by increase of thickness on the under side of the tube, producing similar effect to the above ⊥ bar, which in this position made a difference of strength in the ratio of 1050 to 266 over the former T. But the improvement in strength is made greatly more than the ⊥ form, by continuing the flange, until it meet the bar at the upper side on which the wheels run, as shown in fig. 2.; for a rail weighing 48lb., in this form, is able to sustain, without fracture, a pressure of upwards of ten tons bearing on the centre of it. By this circular or tubular form, in addition to general strength, the rail is secured against *side deflection*, which takes place in the rail at present in use, destroying the power employed, and the rail itself to a great extent, and is generally the cause of a carriage running off the railway.

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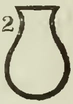

"This, then, may be considered as two important objects gained; that of strength with less material, and avoiding deflection both vertical and horizontal. The chair at the joinings is the next point to call attention to. The hollow rail being circular the chair is formed to embrace more than half of the tube, as illustrated by the diagram given in your paper of the 26th ult., which most effectually secures the rail from rising, or, indeed, from every motion (except expansion or contraction,) merely by the *form*, which supersedes the necessity of locking or keying as hitherto, and avoiding the disagreeable shake in passing over the joinings of the rails; this, therefore, may be stated as a third improvement; as a fourth, the saving of expense, which will be found, *cœteris paribus*, to be greatly less than those at present in use. I have it not in my power to make these rails on a great scale; but I have some yards ready to exhibit to the public, and shall be happy to give every information desired to those who may consider it deserving their attention.—I am, Sir, &c.—*John Ruthven.*" *Scotsman*, September 23, 1837.

Archtec. Mag.

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## *Estimated quantity of coal in the Derbyshire and Yorkshire Coal Fields.*

It has often been asked, how long the mineral resources of Great Britain are likely to prove available? and when we consider that not only our public welfare, but political existence, as a nation, is involved in the result, the great importance of this question must be acknowledged.

By geological investigation, we fortunately find that the time is very far distant when any scarcity of coal is likely to exist. It is with a view of ascertaining our mineral wealth, that I take the liberty of requesting the insertion of this paper in your Journal, the object of which is to estimate the quantity of coal contained in a certain extent of country, and, by inviting similar communications, to arrive at an approximate result for the whole kingdom.

The district that I shall select for elucidation, is that part of the Great Eastern and Midland Counties Coal-field, which lies between a line drawn from Nottingham to Derby, on the south; and another parallel line from Huddersfield to the eastward, on the north; this will comprise a district of country fifty miles in length; the breadth will obviously depend upon the depth to which the various seams of coal may be worked. The development of science, and its application to mining will, no doubt, afford a facility for working mines much deeper than we can at present calculate upon: if, therefore, 500 yards is assumed as an average, it cannot be objected to even as a maximum, that depth having been considerably exceeded at the present time.

The inclination, or dip, of the strata is the next consideration, as several considerable counter basins occur along the district; if 5000 yards is taken for the breadth at which coal may be got at each without exceeding the specified depth, it will be under the average. By inserting sections taken in different parts of the field, it would illustrate the subject, by showing the various beds of coal, their thickness, and where they are now worked, but this would make the present paper too long-winded; I have, therefore, taken the average of several sections; and find that the total thickness of good workable coal exceeds forty-six feet. We have, then, 50 miles × 5000 yards = 90,900 acres, which, at 800 tons per foot in thickness per acre, will give in round numbers 3,490,000,000 tons or 116 years supply for the whole kingdom, at the rate of thirty million tons per annum. The average yield I have taken is less than it ought to be, if the best method of working was adopted, but in some parts of the district, particularly in Yorkshire, there is such a deep-rooted prejudice against the long-work system, that many years will probably elapse before the present slovenly mode of working is abandoned and a more economical one adopted. ALPHA.

Min. Jour.

### *Coal in France.*

Coal mines are worked in thirty-four of the departments of France, but in most of them only to a very small extent. Four-fifths of the entire production are drawn from the four departments of Loire, Nord, Saone-et-Loire and Aveyron. The number of coal mines is stated to be 209, of which only 140 were worked during the year 1834. The quantity of coal extracted was 1,550,530 tons the value of which, at 7s. 6d. per ton, amounted to 581,447*l.* Min. Jour.

## Mechanics' Register.

### *Present state of Athens.*

The *Courier Grec* contains the following article:—There are very few foreigners who have a knowledge of the state of Athens at the present moment. It is commonly judged of from descriptions written before it became the seat of actual government. At that period, Athens presented only an immense mass of ruins, among which there could scarcely be reckoned twenty elegant houses. Two years have elapsed since then, and these ruins have for the most part disappeared; they have been replaced by several paved streets, adorned with fine houses and public buildings. There now exist at Athens a civil and a military hospital. The mint is calculated to attract attention from its fine proportions; adjoining it are several well-built barracks, a printing and a lithographic office, and thirteen small churches. Four large churches and a university are about to be erected. The new palace of the king will bear comparison with the finest Grecian buildings of antiquity. Already there are in Athens twenty public wells, besides which, all the public establishments, as well as many private houses, possess their own wells. The houses pay a small tax for the water. All these wells are supplied from two sources; one of which rises on Pentelicus, and the other at the foot of Hymettus. When the first census was made in 1833, the population was 7000 souls: at present it exceeds 18,000, including the garrison and foreigners. It is rare to meet a beggar in the streets of Athens; and, in fact, their number is small compared with that of the population. For the instruction of youth, the town of Athens possesses great advantages. It is the seat of a Greek university, and of a college, where the government has founded thirty pensions for the benefit of poor students. There is a Greek school, a parish school, and other primary schools for the instruction of children in reading and writing; and we ought not to pass over in silence the girls' school, directed by Madame Volmeranhe, in which fourteen young girls are brought up at the expense of government. (*L' E'cho du Monde Savant*, August 5, 1837.) Arch. Mag.

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## *Vegetable Origin of the Diamond.*

At the late meeting of the British Association, Sir Philip Egerton brought forward a paper furnished by Sir David Brewster, establishing indisputably the *Vegetable Origin of the Diamond.* It is now as certain that crystallized carbon is of vegetable origin, as coal itself. Layers of different degrees of hardness, and possessing different powers of refraction have been found in the diamond; and these layers, which are superimposed on each other like the coats of an onion, possess different specific gravities. It was inferred that the diamond, in its pristine state, must have been a soft body, like amber or gum, and that it was probably expanded by the gaseous bodies imprisoned in its cavities. In commenting on this paper, Professor Sedgwick announced a fact new to us, and probably so to most of our readers, namely, that particles of silica had been discovered in the ashes of burned wood. Mag. Pop. Sci.

## *Lunar Occultations for May* 1838.

LUNAR OCCULTATIONS FOR PHILADELPHIA, MAY 1838.

Angles reckoned to the right or westward round the circle, as seen in an inverting telescope. ☞ For direct vision add 180° ☜

| Day. | H'r. | Min. | Star's name. | Mag. | from Moon's North point. | from Moon's Vertex. |
|---|---|---|---|---|---|---|
| 4 | 14 | 43 | Im. β Virginis | 3, 4 | 41° | 91° |
| 4 | 15 | 35 | Em. | | 263 | 313 |
| 10 | 9 | 57 | { N. App. ☽ & α Scorpii ☽ South 3.'2 } | | | |
| 15 | 14 | 59 | Im. 39 ε Capricorni | 5 | 146 | 111 |
| 15 | 16 | 2 | Em. | | 260 | 234 |
| 27 | 8 | 16 | Im. 19 λ Cancri | 6 | 93 | 150 |
| 27 | 9 | 11 | Em. | | 219 | 274 |

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## *Meteorological Observations for February*, 1838.

| Moon. | Days. | Therm. Sun rise. | Therm. 2 P.M. | Barometer. Sun rise. | Barometer. 2 P.M. | Wind. Direction. | Wind. Force. | Water fallen in rain. | State of the weather, and Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Inches | Inches | | | Inches. | |
| ☾ | 1 | 14° | 26° | 30.20 | 30.10 | W.SW. | Moderate. | | Cloudy—do. |
| | 2 | 21 | 24 | 29.90 | 29.84 | NE W. | do. | | Cloudy—lightly cloudy. |
| | 3 | 15 | 20 | 29.70 | 29.62 | NE. | do. | | Cloudy—do |
| | 4 | 12 | 20 | 29.66 | 29.60 | W. | Boisterous. | | Cloudy.—lightly cloudy. |
| | 5 | 20 | 30 | 29.74 | 29.74 | W. | Moderate. | | Partially cloudy—do. do. |
| | 6 | 20 | 31 | 29 90 | 29.97 | W. | Brisk. | | Clear—do. |
| | 7 | 18 | 38 | 30.00 | 29.90 | SE. | do | .45 | Cloudy—rain. |
| | 8 | 40 | 54 | 29.50 | 29.50 | SW. | Moderate. | | Cloudy—do. |
| ☉ | 9 | 35 | 36 | 29 50 | 29.50 | W. | do. | | Cloudy—do. |
| | 10 | 24 | 32 | 29.70 | 29.70 | W. | Blustering. | | Cloudy—do. |
| | 11 | 26 | 36 | 29.54 | 29.54 | S.W. | Brisk. | | Cloudy—partially do. |
| | 12 | 16 | 32 | 29.95 | 29.95 | W. | Moderate. | | Clear—do. |
| | 13 | 27 | 38 | 29.90 | 29.80 | E.NW. | do. | .46 | Cloudy—do.—rain |
| | 14 | 25 | 27 | 29.85 | 29.90 | NNW. | Brisk. | | Clear—do. |
| | 15 | 14 | 21 | 29.93 | 29.85 | NE. | Moderate. | | Snow—Cloudy. |
| | 16 | 21 | 24 | 29.55 | 29.25 | NE. | do. | .65 | Cloudy—Hail. |
| ☽ | 17 | 9 | 17 | 29.90 | 29.90 | W. | Blustering. | | Clear—do. |
| | 18 | 14 | 29 | 29.83 | 29.75 | W. | Moderate. | | Clear—do. |
| | 19 | 21 | 28 | 29.70 | 29.70 | W. | Brisk. | | Partially cloudy—clear. |
| | 20 | 16 | 25 | 29.75 | 29.75 | W. | do. | | Clear—do. |
| | 21 | 6 | 20 | 29.85 | 29.90 | W. | do. | | Clear—do. |
| | 22 | 13 | 24 | 30.00 | 30.00 | W. | Moderate. | | Clear—do. |
| ⊗ | 23 | 16 | 28 | 29.95 | 29.80 | W. | do. | | Clear—do. |
| | 24 | 20 | 21 | 29.80 | 29.83 | W. | Brisk. | | Clear—do. |
| | 25 | 9 | 19 | 30.00 | 30.00 | W. | Moderate. | | Clear—do. |
| | 26 | 10 | 28 | 29.93 | 29.93 | W | Brisk. | | Clear—do. |
| | 27 | 14 | 32 | 30. 5 | 29.96 | W. | Moderate. | | Clear—lightly cloudy. |
| | 28 | 11 | 24 | 30. 5 | 30. 7 | N.W | Brisk. | | Clear—do. |
| | Mean | 18.42 | 28.00 | 29 81 | 29. 80 | | | 1 56 | |

| | | Thermometer. | Barometer. |
|---|---|---|---|
| Maximum | height during the month | 54.00 on 8th. | 30.20 on 1st |
| Minimum | do. | 6.00 on 21st. | 29.25 on 16th. |
| Mean | do. | 23.21 | 29.82 |

JOURNAL

OF THE

FRANKLIN INSTITUTE

OF THE

State of Pennsylvania,

AND

MECHANICS' REGISTER.

APRIL, 1838.

# Practical and Theoretical Mechanics and Chemistry.

## *On Hydraulic and Common Mortars. By General* TREUSSART, *Inspecteur du Genie. Translated from the French by J. G. Totten, Lt. Col. of Eng. and Brevet Col. United States Army.*

(CONTINUED FROM P. 166.)

### ARTICLE XII.—*Of mortars made of Hydraulic lime and sand, or of Hydraulic lime and Puzzolana.*

After I had become acquainted with the good qualities of the Obernai hydraulic lime, I used it not only for works in water, but also for masonry in the air. It required some patience to change the habits of the workmen, and to bring them to the use of other means than those they had been accustomed to apply to the slaking and management of fat lime; but I was ably seconded by Lieut. Col. Finot of the Engineers, who was charged with the immediate superintendence at Strasburg; and, thanks to his efforts, all the persons employed soon became familiar with the manner of treating hydraulic lime, and excellent results were obtained.

In the observations made by Mr. Vicat on the pamphlet published by me in 1824, he thus expresses himself: "Mr. Treussart pretends that hydraulic limes are only made in order to obtain mortars which will harden in water: so far from that being the case, it may, on the contrary, be said, that hydraulic limes (when the country does not furnish them naturally) are made only because mortars composed of these limes and common sand are, at the same time, the most economical and the best, that have yet been discovered, to brave the inclemences of the weather, resist the alternations of hot and cold, wet and dry, &c."

It is true that at page 46 of my pamphlet I said "The author observes that hydraulic limes are made only to compose mortars which have the property of hardening in water. Since this result is obtained, directly, with fat lime and factitious trass, and the results thus obtained are the best, he thinks this mode the most advantageous." This passage cited independently, might lead to error: but, as in all that preceded, the question was, only, as to works in water, it means that when there are works to be built in water, it is necessary to produce hydraulic mortars; and that when there is not, on the spot, natural hydraulic lime, it is preferable on all accounts, to make hydraulic mortar of fat lime and factitious trass, instead of making artificial hydraulic lime according to the process of Mr. Vicat. I did not in the pamphlet of 1824, give details as to the manner of employing hydraulic lime in the air, because I had not then facts enough to warrant it; but I did not say that they might not be employed with advantage in constructions in the air: very far from that—for my experience having taught me, on several occasions, how dangerous it is to use in the air hydraulic lime that has been too much burned (and I may add that it is as dangerous in the water) I said, speaking of hydraulic limes, at page 5 of the pamphlet, that, "if they are used in the air when too much burned, they may occasion very serious accidents, because they dilate considerably, and may heave up very large stones; it is therefore important to employ this lime only when it is calcined just enough." We see therefore that I was far from thinking that we should not use hydraulic limes in the air: but that I thought it my duty to notify that they must not be made use of when too much burned, because of the serious accidents that might result. If this observation had been attended to, the works of the *Vésére* would not have sustained the serious accidents that obliged them to rebuild several Locks. At Strasburg, care was taken to reject such pieces as were too much burned; and although it often happened that mortar of the ordinary consistency, made of lime just from the kiln, was used, no serious accident befel.

All the officers of the Corps of Engineers are acquainted with Metz, and know the good quality of its hydraulic lime—there used in air as well as in water. I have, myself, used the lime under several circumstances; and, as I observed in the first section, there was built at Strasburg, under my direction from 1816 to 1825, more than a million of masonry, both in air and water, of hydraulic lime. Mr. Vicat was, therefore, altogether deceived as to the sense of the phrase which he quoted; he, moreover, has himself said nearly the same thing: for, in commencing the second section of his work, he says, page 31, "hydraulic mortars, as the name indicates, are designed for masonry to be placed in water: they are also called betons." Were this phrase cited alone, we might apply to Mr. Vicat the reproach he directs to me. I do not think that Mr. Vicat wished us to understand that this lime should not be used in the air; because every body knows that it may. Not only do I think that hydraulic mortars are the best to be used in constructions in the air; but—much more than that, my labours have led me to think that, with fat limes, moderately good mortars cannot be made, in whatever manner treated, if no hydraulic cement be added to them: which is saying, in a word, that the sole means of obtaining good mortars in the air, is to use only hydraulic mortars. The only essential point in which I differ from Mr. Vicat is, that I think—as in mortars for the water, it is preferable to make the hydraulic mortar, directly, with fat lime and factitious puzzolana or other like substance, instead of making hydraulic lime by the process he has indicated. when in a country where there is none naturally good. This method has, besides, the advantage that in countries where the lime is only moderately hydraulic, the mortar may be sensibly meliorated by adding a small quantity of hydraulic cement and a greater quantity of sand, (which would be but a small expense;) while according to the process of Mr. Vicat, it would cost as much to improve, suitably, the moderately hydraulic lime thus at command, as to produce the entire conversion of fat lime into hydraulic lime.

I shall give, in the following tables, results which I obtained with different hydraulic limes from the environs of Strasburg, Metz, and other places.

Table No. XXXV.

| No. of the mortars. | Composition of the mortars. | | | made immediately. | After 15 days | After 1 month. | After 2 months. | After 3 months. | After 4 months. |
|---|---|---|---|---|---|---|---|---|---|
| | | | | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| 1 | Yellow Obernai slaked to powder and measured in powder<br>Sand | 1<br>2 | 3 | 99 | 110 | 132 | 99 | 77 | 66 |
| 2 | Same lime<br>Sand<br>Trass | 1<br>1<br>1 | 3 | 231 | 242 | 262 | 246 | 246 | 220 |
| 3 | Same lime air slaked and measured in powder<br>Sand | 1<br>2 | 3 | | 77 | 44 | 55 | 44 | 44 |
| 4 | Same lime<br>Sand<br>Trass | 1<br>1<br>1 | 3 | | | 231 | 253 | 262 | 253 |
| 5 | Metz lime slaked to powder and measured in powder<br>Sand | 1<br>2 | 3 | 114 | | 88 | 44 | | |
| 6 | Same lime<br>Sand<br>Trass | 1<br>1<br>1 | 3 | 268 | | 231 | 220 | | |
| 7 | Same lime air slaked and measured in powder<br>Sand | 1<br>2 | 3 | | | 66 | 40 | | |
| 8 | Same lime<br>Sand<br>Trass | 1<br>1<br>1 | 3 | | | 242 | 253 | | |
| 9 | Another Obernai lime slaked to powder and measured in powder<br>Sand | 1<br>2 | 3 | 220 | 121 | 88 | 77 | 66 | |
| 10 | Same lime<br>Sand<br>Trass | 1<br>1<br>1 | 3 | 264 | 264 | 286 | 297 | 275 | |
| 11 | Same lime air slaked and measured in powder<br>Sand | 1<br>2 | 3 | | 88 | | 55 | | |
| 12 | Paris hydraulic lime slaked to powder and measured in powder<br>Sand | 1<br>2 | 3 | 187 | | 121 | | | |
| 13 | Common lime reburnt with 2-10 of Holsheim clay, slaked to powder and measured in powder<br>Sand | 1<br>2 | 3 | 176 | | 110 | 88 | 55 | 44 |

*Observations on the experiments of Table* No. XXXV.

All the experiments of this table were made with lime that had been slaked to powder with one-fifth of its volume of water: and the proportions were, one part of lime in powder to two parts of sand.

The first four mortars of the series were made of the same Obernai lime as those of table No. VI which were put into water. No. 1 was composed of lime and sand. If we compare its resistance with that of the like mortar of table No. VI, we shall see, 1st. that the piece of lime which, with sand, produced mortars of feeble consistence in the water, has also given feeble results in the air (it appears that the piece of lime was but slightly hydraulic:) 2d. that the tenacity of the mortars has, alike in both cases, augmented for a certain length of time, after which it rapidly decreased: 3rd. that the mortars left in the air, have generally given a weaker resistance than those placed in water.

Series No. 2 was made of lime, sand and trass, in equal parts. The result we see is much meliorated. The resistance went on increasing like the similar mortar of table No. VI. These mortars, also, exhibited less tenacity than those under water.

Series No. 3 was made of the same lime left to slake spontaneously. The proportion was one of lime, in powder, to two of sand. It was not till after fifteen days that I could procure enough lime in powder to commence the experiment. If the results be compared with No. 1, we shall see that lime air-slaked gave resistances much inferior to those obtained with lime slaked by water to powder—as was the case with mortars put under water.

Series No. 4 was made of air-slaked lime, sand and trass, in equal parts. These results being compared with those of the 2nd. series, we see but slight difference: if compared with the like mortars put under water of table No. VI, we see that they are sensibly inferior.

The series No. 5, 6, 7 and 8 shows similar experiments with Metz lime; these mortars are made of the same lime as those of table No. VII, which were deposited in water. The results given by the Metz lime are weak; but it is probable that with this lime, as with others of the like nature, very different results are afforded by different pieces from the same quarry. I am not entitled to say that the Metz lime is inferior to the Obernai lime, not having made experiments enough with the former to be able to compare. The observations made on the first four series of table No. XXXV, apply, generally, to the mortars made of Metz lime.

Series Nos. 9, 10 and 11 were made of the same Obernai lime, as the mortars of table No V which were put under water: the results are good. No. 9 shows that if not made up till it has been slaked fifteen days, this lime loses nearly one half of its force: and that it loses more and more as this period is extended. If we compare the mortar made immediately, with its analogous experiment in table No. V, we shall see that the mortar left in the air supported 44 lbs. less than the mortar left in water. With the other mortars the differences are not so great.

In comparing series No. 10 above, with the corresponding series in table No. V, we find that the mortar made immediately, gave a resistance only about one-half of that of the similar mortar of Table No V; while the mortar No. 2 of the present table, made of another lime, supported a weight rather greater than the similar mortar of table No. VI, which had been put in water. I cannot explain this anomaly. The other mortars of this series, made at different periods, were inferior, or at most only equal to the corresponding mortars that had been put in water.

The series No. 11 comprises only two experiments with lime left to slake spontaneously: these two experiments consumed all the lime. The results are weaker than the corresponding ones of series No. 9 of which the lime had been slaked to powder with water, agreeing in this respect with the comparison of No. 1 and 3 above.

Series No. 12 comprises two experiments only, made of artificial hydraulic lime manufactured at Meudon, by Mr. Saint Leger. Having but a small quantity of lime, I was unable to make a greater number of experiments. The resistance of mortar made immediately, is good: that made at the end of a month has lost nearly half its force. Two mortars made of the same lime and put into water, are given at No. 1 of table No. X. On comparing them we see that the mortar made at once and left in the air, supported the same weight as that put in water. Mortar made of this lime after being slaked a month, gave when exposed to the air, a resistance of 121 lbs. and when plunged into water, only 88 lbs.

Series No. 13 is of mortar made of an artificial hydraulic lime composed of fat lime and Holsheim clay. The result is nearly the same as that of series No. 12. We see that the strength of the mortar diminished rapidly by the exposure of this lime to the air; and that at the end of four months it had lost three-quarters of its strength.

I made but few experiments with artificial hydraulic limes in the air, but those which I did make, show that they differ in nothing from natural hydraulic limes. They show, also, that in the air, as well as in water, better mortars are generally obtained with fat lime, sand, and substances analogous to puzzolana, than with hydraulic lime and sand.

On comparing the above mortars, left in the air, with the same mortars put in water, we are led to the following conclusions: when mortars are made of hydraulic lime and sand, to be used in masonry exposed to the air, it is of great importance to use the lime soon after it is burned: otherwise it loses a great portion of its force, as it does under water. When we are obliged to wait some days before using it, it should be slaked to dry powder, by throwing on a quarter of its volume of water, and be immediately covered with the quantity of sand that is proper to mix with it to make mortar. These kinds of lime should not be left to slake spontaneously, because they require a considerable time to become reduced to powder, and in general, lose a great part of their energy. Before deciding on adopting the process of air-slaking for hydraulic limes, we should previously convince ourselves by experiment, that the particular limes are exceptions to the general rule; that is to say, that they do not lose a great part of their energy by being left to slake in this manner. If the hydraulic lime we have at command has no great force, we may, nevertheless, make very good mortar by mixing sand, and a quantity of some substance analogous to puzzolana with the lime. For example, with calcined clay-dust of good quality, we may have a mortar of great hardness (even when the lime has very little hydraulic property, or is nothing but fat lime) by mixing lime, sand, and clay-dust, in equal parts: but a less proportion of clay-dust may suffice, with a greater degree of hydraulic strength in the lime, or if the work consist of gross masonry.

Comparing mortars made of the same constituents, and in the same manner —some having been left in the air, and others put under water, we see that the latter, in general, have given the greater resistances. Humidity is, therefore, favourable to hydraulic mortars. In the case of masonry made of fat lime, it has always been recommended, if earth was to be laid against it, that it should be left to dry for some time, before backing it with earth; and with the same object it has been directed to wait a year before pointing the work. We see that with hydraulic mortars used in the air, it will be better to act differently. As the masonry rises, it will be best to throw the earth against it. The pointing should be finished at the same time as the masonry, this being the better and more economical mode. During warm weather, the top of the wall should be copiously watered, at the close of the day, and whenever the masons break off during the day. This was always done at Strasburg, and was found to be a good practice.

I shall give in the following table several experiments that I made with various kinds of lime, in order to know their quality and the quantity of sand that might be mixed with them.

Table No. XXXVI.

| No. of the Mortars. | Composition of the mortars. | | | Weights supported before breaking. lbs. |
|---|---|---|---|---|
| 1 | Yellow Obernai lime slaked to powder and measured in powder<br>Sand | 1<br>2 | 3 | 196 |
| 2 | Same lime<br>Sand | 1<br>2½ | 3½ | 161 |
| 3 | Same lime<br>Sand | 1<br>3 | 4 | 99 |
| 4 | Yellow Obernai lime measured in paste<br>Sand | 1<br>2 | 3 | 301 |
| 5 | Same lime<br>Sand | 1<br>2½ | 3½ | 275 |
| 6 | Same lime<br>Sand | 1<br>3 | 4 | 242 |
| 7 | Another Obernai lime measured in paste<br>Sand | 1<br>2 | 3 | 220 |
| 8 | Same lime<br>Sand | 1<br>2¼ | 3¼ | 165 |
| 9 | Same lime<br>Sand | 1<br>2½ | 3½ | 143 |
| 10 | Same lime<br>Sand | 1<br>2¾ | 3¾ | 88 |
| 11 | Same lime<br>Sand | 1<br>3 | 4 | 66 |
| 12 | Yellow lime of Bouxviller measured in paste<br>Sand | 1<br>2 | 3 | 231 |
| 13 | Same lime<br>Sand | 1<br>2¼ | 3¼ | 242 |
| 14 | Same lime<br>Sand | 1<br>2½ | 3½ | 253 |
| 15 | Same lime<br>Sand | 1<br>2¾ | 3¾ | 231 |
| 16 | Same lime<br>Sand | 1<br>3 | 4 | 187 |
| 17 | Oberbronn lime measured in paste<br>Sand | 1<br>2 | 3 | 297 |
| 18 | Same lime<br>Sand | 1<br>2½ | 3½ | 165 |
| 19 | Yellow Obernai lime alone—reduced to paste | | | 323 |

### *Observations on the Experiments of Table* No. XXXVI.

The first three numbers were made of the yellow Obernai lime, slaked to powder soon after leaving the kiln. The proportions were one part of lime to the several quantities of sand stated in the table. We see that the strongest result corresponds with the least quantity of sand. Different circumstances having taught me that hydraulic lime would not bear as much sand as is commonly thought, I proportioned the following mortars with lime measured in paste.

Nos. 4, 5 and 6, were made at the works, and consequently with mixed pieces of lime; the proportions are shown in the table. The best result answers to one of lime and two of sand, and it will be remarked that these three mortars are superior to the first three, which I attribute principally to a smaller quantity of sand.

The numbers from 7 to 11, were made of lime from another burning: the sand was augmented each succeeding trial by a quarter of the bulk of lime, while in the preceding experiments it had been augmented by a half. The best result corresponds with one part of lime in paste to two parts of sand; it is possible that a smaller proportion of sand would be still better, for we see that No. 19, which is lime reduced to paste without any sand, gave a stronger result; but as No. 19 was made of lime of another burning, I placed it at the end of the table that it might not lead to any false conclusions. I did not anticipate that there may be good hydraulic limes which will support only a very small quantity of sand; otherwise, I should have commenced the series with a much smaller proportion.

The numbers from 12 to 16, are mortars made of the hydraulic lime of Bouxviller, a small village situated at the foot of the Vosges, between Haguenau and Savern. This lime was treated in the same way as the Obernai lime that precedes it in the table. We see that the Bouxviller lime will bear more sand than that from Obernai, and that the best result corresponds to the proportion of one part lime measured in paste to two and a half parts of sand. The lime was of the same burning as that used in table No. III. Comparing the figures of the two tables, I was surprised to see that the same lime supported more sand in the air than in the water, which has happened very rarely in the course of my experiments; I am ignorant whether this is owing to some peculiar circumstance, or is a quality pertaining to certain hydraulic limes.

The experiments Nos. 17 and 18, were made with lime from Oberbronn, a village at the foot of the Vosges, to the left of the road from Haguenau to Bitche. I obtained a very good result with one part of this lime measured in paste and two parts of sand; but No. 18 shows that by putting two and a half parts of sand in the mortar, it lost nearly half its force. When making these two experiments with Oberbronn lime, I put, on one side, a fragment which I slaked with one-fifth of its volume of water, so as to reduce it to dry powder. I left it in this state, in the air, for fifteen days. I then made a mortar like No. 17. This mortar broke with the weight of 132 lbs., in lieu of the 297 lbs. which the mortar supported when made of lime just slaked. I obtained a similar result with the Bouxviller lime. All the limes, therefore, which I have used in my experiments in the air, and which are included in the preceding tables, require to be used a very short time after being burned: they lose, otherwise, a great portion of their energy; as is also the case when they are used in water.

No. 19 was made, as I have said, of Obernai lime, alone, reduced to paste with water. When I saw the hardness of this hydrate, my intention was to make similar trials with other limes, in order to know if the sand added in the composition of mortars, always, or only with some peculiar limes, diminished the resistance of the hydrates: but I was obliged to quit Strasburg before it was in my power to make the essays.

## ARTICLE XIII.—*Various experiments with Mortars exposed to the Air.*

In this article I shall give several experiments which I made on mortars exposed to the air. Several are repetitions of those contained in article VII, of mortars placed in water.

### Table No. XXXVII.

| Composition of the mortar. | Made immediately. | After 12 hours. | After 21 hours. | After 36 hours. | After 48 hours. | After 60 hours. | After 72 hours. | After 84 hours. |
|---|---|---|---|---|---|---|---|---|
| | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| Obernai lime slaked to a moist powder, with a volume of water equal to the volume of lime . . . . . 1 } 3<br>Sand . . . . . 2 | 220 | 209 | 165* | 132 | 132 | 110 | 92 | 68 |

### *Observations on the experiments of Table* No. XXXVII.

The above experiments were made with the same lime, and in the same proportions, as those of table No. XXVI, of which the mortars were put in water. For the manner of operating, I refer, therefore, to the observations on table No. XXVI.

These air mortars behaved like those placed in water. The mortar made immediately, afforded, in the air, a resistance rather less than the corresponding mortar of table No. XXVI; the others gave results about the same in the two cases. It is therefore important not to slake hydraulic lime with too much water, whether it is to be used in the air or in water; and we perceive that the method proposed by Mr. Lafaye is very inconvenient for hydraulic lime, because it requires the quick lime to be broken into small pieces of nearly equal size, which is a long and expensive operation. Unless this be done, the small pieces will absorb too much water, and the large pieces too little.

### Table No. XXXVIII.

| No. of the mortars. | Composition of the mortars. | Weights supported before breaking. |
|---|---|---|
| | | lbs. |
| 1 | Mortar made of equal parts of common lime, sand and trass | 143 |
| 2 | Same mortar, worked anew, without water, after 12 hours | 154 |
| 3 | Same mortar, worked anew with a little additional water, after 12 hours . . . . . . . | 209 |
| 4 | Same mortar, do. after 24 hours | 198 |
| 5 | Same mortar, do. after 36 hours | 165 |
| 6 | Same mortar, do. after 48 hours | 187 |
| 7 | Mortar of 1 part of Obernai lime and 2 parts of sand . | 154 |
| 8 | Same mortar, worked anew with a little additional water, after 12 hours . . . . . . . | 176 |

### *Observations on the experiments of Table* No. XXXVIII.

These experiments were made with the same lime as, and in a similar manner to, those recorded in table No. XXVIII. The first six mortars correspond to Nos. 1, 3, 4, 6, 8, and 10, of that table, which were put under water. I made similar trials with lime and sand only; but, as I used lime which had been slaked for some time, I obtained only feeble results—the greater part of the mortars not supporting the weight of the scale pan.

If we compare No. 2 of the above table with No. 1, we see that the mortar that was reworked without water, after twelve hours, gained but little upon that which had not been reworked; but that No. 3, which had been reworked with a little water, had gained a good deal. After twenty-four hours, the mortar No. 4 had become so dry that it was impossible to rework it without water; I was therefore obliged to moisten it a little, like No. 3. We see that the result was about the same as at the end of twelve hours. After thirty-six hours the hardness had become sensibly weaker, and at the end of forty-eight hours it had become stronger than at the end of thirty-six hours—an anomaly which I cannot explain.

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*This mortar was cracked, which may have lessened its resistance.—Author.

Comparing the results of the above table with the corresponding ones of table No. XXVIII, we find that the resistances of the mortars left in the air are sensibly less than those placed in water. We see also that in both cases, I obtained no advantage of consequence, by reworking the mortars without additional water; but that there was a material augmentation of force, on reworking the mortars with a little water.

Nos. 7 and 8, of the above table, answer to Nos. 13 and 14 of table No. XXVIII, and were made of the same lime. There is in these mortars, also, much resemblance as to the effect of reworking upon mortars in air and in water; that is to say, the mortar which had been reworked with a little water after twelve hours, presented a greater resistance than that which had not. The resistances of these tables are generally rather weak, because of my using lime which had been slaked for about fifteen days.

At all works, it is often necessary to rework the mortars in the course of the day, especially in hot weather, when it dries very quickly and becomes too stiff to be used. During the hours of recess from labour, and when the works are interrupted by rain, the mortar will harden considerably. It would sometimes demand a great deal of labour to restore the mortar to a suitable consistency without water. My practice has always been to add a little water whenever the mortar had become, from any cause, too stiff, and required reworking. The preceding remarks show that no disadvantage attends this mode of operating. There is, no doubt, a limit, both as to the quantity of water to be added, and as to the time elapsed before reworking; and I purposed making other experiments in order to ascertain these limits, but I had not time. The experiments cited are nearly sufficient, and they prove that the opinion on which is founded the saying that "*mortar should be tempered with the sweat of the workmen,*" is a prejudice leading to considerable useless expense. The essential point is, that the lime, and the substances added to it, be intimately mixed; and this is most easily accomplished when the mortar is soft.

Table No. XXXIX.

| No. of the mortars. | Composition of the mortars. | | | Weights supported before breaking. |
|---|---|---|---|---|
| | | | | lbs. |
| 1 | Obernai lime slaked to powder, with 1-5 of its volume of water, leaving it in the air . . . | 1 | 3 | 154 |
| | Sand . . . . . . . | 2 | | |
| 2 | Same lime, slaked to powder with 1-5 of its volume of water, covering it with sand . . . | 1 | 3 | 154 |
| | Sand . . . . . . . | 2 | | |
| 3 | Same lime, slaked by plunging it into water for fifty seconds . . . . . . | 1 | 3 | 132 |
| | Sand . . . . . . | 2 | | |

### *Observations on the experiments of Table* No. XXXIX.

These experiments are the repetition of those described in table No. XXV, and they were made of the same lime. The results are similar to those given by mortars put under water; only they are a little weaker. The comparison of Nos. 1 and 2 shows that there is no advantage, when slaking lime, to cover it with sand. This is called *stifling* the lime; and several constructors think that the vapour which rises, on slaking, possesses valuable properties.

Mortar No. 3 of table No. XXXIX was made of the same lime as No. 3 of table No. XXV, and I used, in slaking the lime, the process recommended by Mr. Lafaye, which consists in dipping the quick lime into water. The resistance was less than No. 1, which was slaked by throwing on a little water. This appears to me to be owing to the pieces of lime absorbing too much water from being in small pieces; and as the lime remained twelve hours in this state, it lost a part of its force—for it follows, from tables Nos. XXVI and XXVII, that lime, slaked to a humid powder has already lost a part of its energy, when it has lain twelve hours exposed to the air.

### Table No. XL.

| No. of the mortars | Composition of the mortar. | | | Weight supported before breaking. |
|---|---|---|---|---|
| | | | | lbs. |
| 1 | Common lime measured in paste | 1 | 3½ | 297 |
| | Pulverized bricks lightly burned | 2½ | | |
| 2 | Same lime | 1 | 3½ | 143 |
| | Pulverized bricks well burned | 2½ | | |
| 3 | Same lime | 1 | 3½ | 253 |
| | Pulverized tiles lightly burned | 2½ | | |
| 4 | Same lime | 1 | 3½ | 99 |
| | Pulverized tiles wellburned | 2½ | | |
| 5 | Same lime | 1 | 3½ | 0 |
| | Pulverized tiles lightly burned—recalcined for six hours. | 2½ | | |

### *Observations on the experiments of Table* No. XL.

The above experiments are of the same kind as those made with mortars put under water, and reported in table No. XVI. These air-mortars gave similar results with those put in water; that is to say, those made of pulverized bricks, or tiles, but lightly calcined, gave much better resistances than those made of more highly burned bricks or tiles. We see that the dust of No. 5, which had been recalcined by being kept red hot for six hours, gave with the same lime, a mortar that had no strength. The dusts used in these trials, like those of table No. XVI, contained a notable quantity of lime. The resistances of the mortars left in the air, were, in this instance also, rather less than those of the mortars put in water.

## Table No. XLI.

| No. of the mortar. | Composition of the mortar. | | | Weight supported before breaking. |
|---|---|---|---|---|
| | | | | lbs. |
| 1 | Common lime measured in paste<br>Brick dust . . . . | 1<br>2½ | 3½ | 132 |
| 2 | Same lime . . . . .<br>Brick dust, same as No. 1, recalcined for half an hour . . . | 1<br>2½ | 3½ | 165 |
| 3 | Same lime . . . . .<br>Brick dust same as No. 1, recalcined for one hour . . . . | 1<br>2½ | 3½ | 275 |
| 4 | Same lime . . . . .<br>Brick dust, same as No. 1, recalcined for two hours . . . . | 1<br>2½ | 3½ | 308 |

### *Observations on the experiments of Table* No. XLI.

These experiments correspond with those of table No. XVII, that is to say, having used brick dusts which gave resistances the feebler the more they were burned, as those of tables Nos. XVI and XL—other brick-dusts were found, as those of tables Nos. XVII and XLI, which gave results exactly opposite. The mortars of the two tables XVII and XLI, gave in air and in water, results so much the stronger as the cements had been the more burned. In speaking of tables Nos. XVI and XVII, I said, that the differences were owing to the cements of table No. XVI, containing much lime, while those of table No. XVII, contained little. But the cements of tables Nos. XL and XLI, were the same as those of tables Nos. XVI and XVII, and the results in the air were just like those in the water. The comparison of these four tables leads to an important conclusion; namely, that clay-dusts which give results with fat lime, when placed under water, will also give good results, when exposed to the air: and if the results be bad in the first case, they will be equally so in the second. Whence it follows that to know whether clay dust which is to be used in air mortar, will give good results it should be tried with fat lime in water; following the process pointed out in the first section. We may be certain that cements which have not the property of causing fat lime to harden in water, will give, in the air, no better results than the same lime mixed up with sand alone. On the other hand, the more hydraulic the cements are, the better, for all uses in the air. The trials of which we have spoken, should not be neglected, for they are of great importance, as regards the solidity of masonry exposed to the air.

## Table No. XLII.

| No. of the series. | Composition of the mortars. | Weight supported before breaking. |
|---|---|---|
| | | lbs. |
| 1 | Obernai lime alone, reduced to paste . . | 323 |
| 2 | Verdt lime alone, reduced to paste . . . | 99 |
| 3 | Metz lime alone reduced to paste . . . | 119 |
| 4 | Lime from the Boulogne pebbles . . . | 99 |
| 5 | Mortar composed of one part of fat lime that had been long lying slaked and wet, measured in paste—and two parts of puzzolana . . . | 429 |
| 6 | Mortar made of one part of same lime do. and two parts of trass . . . | 451 |
| 7 | Mortar do. do. do. and two parts of Sufflenheim cement . . . | 429 |
| 8 | Mortar do. do. do. one of sand and one of Sufflenheim cement . . | 363 |
| 9 | Mortar do. do. do. and two pars of forge scoriœ . . . . | 55 |
| 10 | Mortar do. do. do. one of sand and one of Paris cement . . . | 0 |
| 11 | Mortar made of one part of fresh lime measured in paste and two parts of common sand . | 77 |
| 12 | Mortar do. do. do. and two parts of common sand pulverized . . | 121 |
| 13 | Mortar made of one part of Obernai lime measured in paste and two and a half parts of common sand | 187 |
| 14 | Mortar of one part of same lime do. and two and a half of sand, pulverized . . | 275* |
| 15 | Mortar of one part of quick-lime but little burned, measured in paste, and two parts of sand . | —22 |
| 16 | Mortar made of one part of Lixen lime measured in paste and two parts of earthy sand . | —22 |
| 17 | Mortar of one part of same lime do. and two parts of River sand - . . | 143 |
| 18 | Mortar of one part of do. do. and two parts of earthy sand, washed . . . | 176 |
| 19 | Mortar of one part of Dosenheim lime and two parts of earthy sand . . . | —22 |
| 20 | Mortar of one part of same lime and two parts of river sand . . . . | 132 |
| 21 | Mortar of one part of do. and two parts of eartby sand washed . . . | 176 |

*Observations on the experiments of Table* No. XLII.

This table contains a variety of experiments, which I will explain. Nos. 1, 2, 3 and 4 were made of lime slaked soon after being burned, and by the necessary quantity of water, reduced at once to paste. These hydrates of lime like the mortars which precede them, were placed in a cellar, and tested at the end of a year. The hydrate of Obernai lime, No. 1, was very good. No. 2, a hydrate of Verdt lime, gave so feeble a result as to surprise me, after that which I had obtained by placing a hydrate of the same lime in water—table No. III shows that the resistance of this hydrate was 484 lbs. As the specimens were from different burnings, I presume that in this last trial, I used a piece but feebly hydraulic. The Metz lime

*This mortar being a little cracked, its resistance was diminished.

No. 3, gave a feeble result, also. I have already said that I made but few experiments with this lime, and it is possible that the small quantity that was sent me was, by accident, but feebly hydraulic. No. 4 was from the Boulogne pebbles, and was treated the same way as the preceding. The resistance was feeble, and, we have seen (table No. VIII) that, with a single exception of a trial made with this lime highly calcined, all the mortars it has furnished, have supported but small weights. The above lime, No. 4, had received only the ordinary calcination.

Nos. 5, 6, 7, 8, 9 and 10 were made of fat lime that had been lying slaked, and wet, for five years, since the erection of the Theatre. The proportions were one part of this lime in paste, to two parts of the several substances mentioned in the table. The mortar No. 5, composed of this lime and puzzolana, gave a very good result. No. 6 made, in the same manner, of trass, gave a resistance a little better still. Mortar No. 7 made of the hydraulic cement of Sufflenheim, gave a resistance equal to that afforded by puzzolana. Mortar No. 8 made of equal parts of lime, sand and Sufflenheim cement, supported a weight rather less than No. 7, in which there was no sand. No. 9 was made in the same manner as the preceding mortars, using the scoria of forges. I satisfied myself that these scoria contained little or no clay; and it is to this that I attribute the bad result. I said in the first section, that with the Tournay ashes, and the ashes of the forges of Boulogne, very good mortars were made; owing to this, that the sea-coal, burned in the forges of those places, contained a considerable quantity of clay, which was calcined in a current of air, by the combustion of the carbon of the coal. The scoria of forges, and the ashes of furnaces, should not, therefore, be used in mortars in the air, before ascertaining whether these matters have the property of causing lime to indurate under water.

No. 10 is a mortar composed of one part of fat lime measured in paste, one part of sand, and one of Paris cement. This cement was from the manufactory of Mr. Saint Leger, and was the same as that used for the mortars put into water. We saw, at page 22, that two mortars made of this cement had promptly hardened in water, but that both were cracked. The mortar made of one part lime and two parts of cement supported 187 lbs., and that made of lime, sand and cement, supported only 99 lbs. I was much surprised at the bad result of the mortar No. 10 in table No. XLII; it had so little consistence that it crumbled easily between the fingers. I attribute the bad effect to the great quantity of lime that Mr. Saint Leger mixed with the clay, in making the cement. It might be that the cement was too much burned. Some separate trials lead me to think that cements made of clays containing about one tenth of lime, are less proper for mortars in the air than for mortars in water: it appears also that they allow but little sand in the composition of the mortar. I intended making some experiments to settle this matter but had not time. My departure from Strasburg also prevented my making, with the several clays of the environs of that place, experiments in the air, analogous to those which I made with the clays, under water. My various essays, however, induced me to think that in making artificial puzzolanas for mortars intended to be exposed to the air, the presence of lime in the clays to be calcined, is still more hurtful than when the mortars are to be used under water. Clay, therefore, should be chosen which contains no lime or very little.

Nos. 11 and 12 were made of fat lime reduced to paste shortly after burning. No. 11 was made of one part of this lime measured in paste, and two parts of common sand. No. 12 differs only in having the sand pulverized. We see that the result was much better with the fine sand. Nos. 13 and 14 were similar experiments made of Obernai lime. With the fine sand, the resistance was, in this case also, much the greatest, although the mortar was so cracked as necessarily to diminish its force. We have seen in table No. XXIX, that mortars in water gave similar results. We ought to conclude, therefore, that whether for mortars in air or in water, fine sand is the best, notwithstanding the opinion to the contrary of most constructors.

Old mortars are often found which are very hard, and which contain a great quantity of gravel as large as a pea. This fact is sometimes cited to prove that it is best to use coarse sand in gross masonry, but the reasoning is not just. These kinds of mortars are really concretes: the gravel they contain can have no influence on the goodness of the mortar. But if this gravel is mixed with fine sand (as is often the case) and the lime is hydraulic, then a very good mortar is obtained—the strength of the mortar depending on the strength of the lime.

No. 15 was made of lime which had been placed above the tiles in the kiln, and was, therefore, but slightly burnt: it was the same lime as was used in making the mortar to be put in water, No. 8 of table No. XXIX. Only bad mortars were obtained by this means, either in the air or in water.

Nos. 16, 17 and 18 were made of three different kinds of sand and a lime moderately hydraulic, obtained from the village of Lixen, near Phalsburg. No. 16 was made of one part of this lime, measured in paste, and two parts of a very earthy pit sand, which is found in the neighbourhood. The resulting mortar had so little consistency, that it could not bear the weight of the scale pan. No. 17 was mixed in the same proportions with river sand from Zorn, near Saverne; the resistance was passable. The same proportions were observed, in mixing No. 18, with the same sand as was used in No. 16, after being freed, by washing, from earthy matter. We see that this mortar was good, and superior to the mortar made of river sand.

Nos. 19, 20 and 21 were repetitions of three preceding experiments: using, however, another lime, also moderately hydraulic, obtained from the village of Dosenheim. The mortars made of Dosenheim lime, like those made of Lixen lime, prove that earthy sands afford only very bad mortars; but that, being washed, they are superior to river sands. I was led, in 1823, to make these experiments, because there was to be had near Phalsburg only pit sand which was half earth. Whenever there was any work to be executed requiring some care, the people of that place were obliged to get river sand from the river Zorn on the other sides of the Vosges. This brought the price to about \$0.03½ per cubic foot—so high as to prevent its being procured for the masonry of revetments: it resulted that the masonry of that place, made of mortar in which the earthy sand of the neighbourhood was used, has needed considerable repairs, and in making the necessary reconstructions, it was very apparent that the degradations had been owing to the bad quality of the mortar.

After getting the results of these last experiments, I used no sand at Phalsburg except washed pit sand. It required 70.68 cubic feet of the earthy sand to yield 35.34 cubic feet of the washed sand: 0.62 of a day's work sufficed for the washing: it would, therefore cost less than one half of the expense of bringing the river sand.

The sand may be washed on a large scale in the following manner; a basin being made of masonry from seven to ten feet wide, and from twelve to sixteen long, the height of the walls should be about two and a half feet, with the exception of one end, which should be only one foot two inches high; the bottom should be paved with flat stones; the basin should be built near a stream of water, or if that be not practicable, a well should be sunk near it. A layer of sand of about one foot thick, should be placed in the basin, and a plank one foot four inches wide placed on edge, on the low wall, raising it to the height of the other walls—the plank being fitted into grooves made in the side walls to receive it. The basin must then be filled with water from a brook, or from a pump in a well, as the case may be; and the sand must be well stirred up with *rabs* by two or three labourers. Allowing the time found to be necessary for the sand to precipitate, the plank must be suddenly withdrawn, and a great part of the water will pass off at once, loaded with earthy matter. This operation must be repeated until the water passes off but slightly turbid: the sand may then be taken out and left to dry, and the washing be applied to another portion.

For economy, the basin may be constructed of planks, as was done at Phalsburg. It was six feet eight inches long, four feet four inches broad, and two feet two inches deep. There was left in front an opening of only fourteen inches deep by ten inches broad. But this opening was too small for the water to run off rapidly. It is best to place a movable plank of some breadth across the whole front of the basin, so that the water may pass off very quickly.

The last experiments of table No. XLII, show how important it is to use clean sands in making mortars: but before washing off the earthy matter, it is proper to be satisfied, by the means I have pointed out, that the sands are not arenes.

## ARTICLE XIV.—*Observations on Mortars exposed to the Air.*

It results from the experiments given in articles XI, XII, and XIII, that in exposing to the air mortars made of sand, and lime which had been laying a long time slaked and wet, I obtained no satisfactory result; while I obtained tolerable results with sand, and the same lime recently slaked. The resistances of these last mortars were 68, 77, and 99 lbs., while the others were unable to support the scale pan, whatever may have been the process of fabrication. I ought not, however, from this to take up a general conclusion, and counsel against slaking and running lime into vats to preserve it; because I have not made experiments enough to pronounce positively on the subject—which is one of great importance. It is necessary to repeat these trials in different countries, so as to operate on various kinds of lime, before proscribing this method; which, while it may be a bad method for certain kinds of lime, may be very good for other kinds. I do not know for how long a time the method of running lime into vats has been followed. It may have been introduced in consequence of the considerable increase of bulk which it gives. I do not know that it was followed by the ancients. Vitruvius has left a work on architecture, in which he has given many details as to the manner the Romans carried on their works. We find in this author, as rendered from the Latin by Perrault, the architect, the following passage extracted from Book II, chapter V: " When the lime has been slaked, it must be mixed with sand, in such proportions that there shall be three parts of pit sand, or two parts of river sand to one of lime: because this is the most just proportion of the mixture, which will be much better still, if there be added to the sea or river sand a third part of sifted tile dust."

We see nothing in this passage that indicates the mode of slaking; but it is certain that the Romans made great use of hydraulic lime, as there are many remains of their works in countries where this lime abounds: such are the constructions they have left us on the banks of the Moselle, and in several parts of France. But these limes could not be slaked and left in the above manner, (as they would harden in the water;) and, if it had been the practice to slake them differently from fat lime, Vitruvius would no doubt have mentioned it. It appears probable to me, therefore, that the Romans used fat lime as they did hydraulic lime, that is to say, immediately after the burning. This is the more likely, as Vitruvius directs, in the process of stucco making, that only lime that had been long slaked should be used. The following are his remarks on this subject. Book VII, chapter II. " Having examined all that appertains to pavements, the manner of making stucco must be explained. The principal matter in this is, that the lime should be slaked for a long time, so that if there should be some particles less burned than the rest, they may, having time thus given them, be as thoroughly slaked, and as easily tempered, as that which was thoroughly calcined: for, in lime which is used as it comes from the kiln, and before it is sufficiently slaked, there is a quantity of minute stones imperfectly burned, which act on the plaster like blisters, because these particles slaking more slowly than the rest of the lime, break the plaster and mar all the polish." It appears to me that the precaution of slaking the lime a long time before hand, is here recommended as an exception, and that in the mortars intended for masonry, the Romans used all limes soon after they left the kiln. It is remarkable that the same author directs, in the first passage cited, mixing with the mortar a portion of sifted tile dust, observing that it will much improve the mortar.

We have seen that my experiments were very unfavorable to the process indicated by Mr. Loriot and Mr. Lafaye: they were in error in recommending them as, in principle, recovered from the Romans. Moreover, these processes have, for a long time, justly fallen into disrepute.

As to the opinion that the hardness of mortar is due to the regeneration of carbonic acid, I have shown that according to the analysis of Mr. Darcet and Dr. John, several ancient mortars, although very hard, contained but a small portion of the carbonic acid necessary to the saturation of the lime. It has been stated that the Italians sell little caskets and snuff boxes which they make of ancient Roman mortars: but it has been noticed that they use for these purposes only the exterior parts of the mortar in which the lime had passed to the state of carbonate, while the interior often afforded but a weak consistence.

In examining Roman mortars, it is observed that they are often of great hardness, although it is evident that the mixture had been made with very little care. We must therefore attribute the hardness of these ancient mortars to other causes; for, as I have said, all these mortars are not by many degrees equally hard.

To explain the hardness of Roman mortars, it will suffice, I think, to cast the eyes over tables Nos. XXXVI, XL, XLI, and XLII. Table No. XXXVI contains mortars made of hydraulic lime and sand. These mortars exposed to the air for one year only, show great tenacity. Tables Nos. XL, XLI, and XLII, contain, also, very good mortars made of fat lime, puzzolana, trass, and several kinds of cement. The use of cement goes back to high antiquity, for Roman and Egyptian structures often contain it. Those who wish to solve this question, without recourse to the quality of the lime, or to cements, object that there are ancient remains which appear to have been made of fat lime, since they are seen in countries where no puzzolana or hydraulic limes are to be found, and they have not the aspect of mortars made with cements. I will observe, touching this point, that if we examine the two tables in pages 87, which contain the analyses of several lime stones, we shall see that many limes which are ranked with fat limes contain, nevertheless, small quantities of clay. Although they may not contain enough clay to harden under water, they ought to afford much better mortars in the air than those limes which contain none. Again, hydraulic limestones are often found disseminated amongst the strata of fat lime stones. And, lastly, the important observation of Mr. Girard, on the hydraulic proportions of *arenes* explains easily how very good mortars may have been made of fat lime. I will observe, in addition, that the Romans, in all the countries they occupied, executed a great many works, of which only those made of good mortars survive to the present day. Saint Augustine complains of the manner in which mortars were made in his day: and the same complaints are found in Pliny; who says, chapter XXII, "that which causes the ruin of the greater part of the edifices of this city (Rome) is, that the workmen employ, from fraud, in the construction of the walls, lime which has lost its quality."* We see, therefore, that all the Roman mortars were not good.

For my part, I am convinced, that if those ancient constructions that have reached our times, be examined with attention, it will be ascertained that they were made either with hydraulic lime and sand, or with fat lime and sand mixed with cement, or with arenes: in a word, that these mortars had all the elements of good hydraulic mortars.

We are in the habit of composing our mortars of fat lime and sand; the preceding experiments show that we are wrong: our mortars have, consequently, little durability. We shall not obtain durable masonry in the air, until we make use, therein, of hydraulic mortars. In countries where good natural hydraulic lime is to be had, no other kind should be used for any purpose whatever. For ordinary masonry, the mortar should, in that case, be made of lime and sand only. In countries where there are no natural hydraulic limes, but where there are arenes, the mortar should be made of fat lime and these arenes: in both these cases the mortars would be cheap. In countries where neither arenes nor hydraulic limes are to be procured, it will be necessary to incur a little additional expense, and make use of fat lime, sand, and hydraulic cement. To combine economy and solidity at the same time as much as possible, the proportions, in cases where there are to be one part of fat lime and two of sand and cement, the mixture may be made as follows, viz: one part of fat lime measured in paste, one and a half of sand, and a half of hydraulic cement; (according to similar proportions made with trass, as shown in table No. XXVII,) we should have, by this means a very good mortar. The proportions of hydraulic cement, stated above, should be used in all common masonry: in works demanding more care, the mortar should be composed of lime, sand, and cement, in equal parts. I have said, that the proportions indicated for common masonry, should augment the expense but little: but were the augmentation more considerable, it is certainly much more economical to incur at once, all the expense necessary to produce a permanent work, than to build at a cost rather less in the first instance, and to be obliged to reconstruct the work entirely, after no great lapse of time. A government should construct for posterity: and I do not doubt that this end would be attained by making all masonry with hydraulic mortar, in the manner I have pointed out.

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*We might infer, from this passage, that Pliny complained because the lime was not used soon after its calcination. AUTHOR.

Officers of engineers often have to construct arched rooms, passages, &c., that are to be always covered with earth. The mortar of these constructions is generally composed of fat lime and sand. To resist filtration and humidity, it is customary to place a cap, or masonry roof, made of hydraulic mortar, over these arches: but experience shows that these caps do not fulfill their object, and that they often afford a passage to the water, especially when made of bad cements. I cited an example at page 23, and I might cite many others. Even when the caps are made of good mortar, it may happen that there is humidity in the casemates, and that the arches leak: for we have seen at page 160 that mortars made of fat lime do not dry completely, even in a century, when the walls are thick. And this result is the more certain when the masonry is covered with earth as in casemates. The walls against which the earth lies, almost always allow the water to transude, although the cap may be impermeable. Besides, from the considerable load that these arches often sustain, the masonry that has been made of mortar slow to harden, will settle, causing cracks and leaks in the caps. The only means of obviating these disadvantages, is to construct all the masonry of the casemates with hydraulic mortar. We shall thus secure the great advantage of a prompt induration: the subsidence will consequently be less sensible, and cracks less apt to occur; the walls will no longer allow moisture to transude, and even should there be some cracks in the caps, the water will, with difficulty, find its way through arches made with hydraulic mortar.

The manipulation of mortars designed for exposure in the air, should be the same as that described in the first section for mortars designed for water.

## ARTICLE XV.—*On factitious Stones and Concretes, exposed to the Air.*

Mr. Fleuret, formerly Professor of Architecture in the Royal Military School, of whom I have before had occasion to speak, published in 1807, a work on the art of composing factitious stones. The following passages are to be found in page 12: "The art of building with factitious stones is very old; it was in use with the Babylonians, and the early Egyptians, amongst the Greeks and Romans, and it is still pursued in Barbary, and amongst the nations of Malabar.

"According to Pliny, the columns which adorn the peristyle of the Egyptian labyrinth, were of artificial stones, and this vast edifice has existed three thousand six hundred years. The pyramid of Nynus is formed of a single block. The enormous stones composing the great and strong walls raised in the empire of Morocco, as is reported by the Abbe de Marsi, from writers whom he quotes; the square stone that formed the tomb of Porsenna, spoken of by Varro and Pliny, which was thirty feet wide by five feet high, were composed in the same manner as the pyramid of Nynus, and lead us to believe that these monuments owe their existence and their preservation to a process as easy as it is simple, and which unites the advantage of solidity with economy.

"All factitious stones of a volume thus considerable, were made by encasement, and the process of massivation; that is to say, that in the great walls built thereof, these stones were formed the one upon the other, by beating the materials, with rammers, into spaces formed by planks, as I shall explain."

Mr. Rondelet states, in his preface, that the columns of the choir of the church of Véselay, in Bourgogne, were ascertained to be factitious stones by Marshal Vauban, and the pillars of the church of Saint Amand, in Flanders, were made in the same manner.

I have had no opportunity to ascertain whether blocks of stone of extraordinary dimensions, were factitious; this question could not be well settled, except by examination of the masses themselves. It is possible that several of the large blocks mentioned were factitious: but it is not easy to believe, in a wall formed of large pieces placed one upon another, that these large pieces are factitious, for it seems to me that it would be much more difficult to construct a wall of that sort, than to make the whole wall of one piece, whereby the moving and transportation of masses of an enormous weight would be avoided. I do not at all doubt that artificial stones of large dimensions may be made, for all depends on making a good mortar: nevertheless it seems proper not to admit such facts as are cited above without a thorough examination.

The Italians, at Alexandria, make very good factitious stones with the Casal lime, and employ them in angles; they are four feet eight inches long, by two feet eight inches wide, and two feet eight inches high; they are buried under ground for two or three years, and there acquire great hardness. These stones are made in the following manner. For one cubic yard they take 0.24 of Casal lime measured in paste, and 0.90 of sand. These are well mixed together, adding the water necessary to form a paste, and there is then added 0.20 of pebbles, *(cailloux;)* these factitious stones are therefore real concretes. Their goodness depends on the quality of the mortar applied to making them. Mr. Fleuret proposes to make the mortar for these factitious stones in the following manner.

He slakes the lime by immersion, according to the process of Mr. Lafaye, to which he attaches great efficacy. When slaked to dry powder, it is to be deposited in a dry situation, enclosed in casks covered with straw mats loaded with stones. He recommends that, each time the cask is resorted to for lime, a part only of the mat should be raised, and that it be replaced as soon as possible, in order to guard gainst the contact of the air, which he says is very hurtful. He makes a perfect mixture of sand and clay dust, in the proportion of two measures of sand to one of dust; or, which is better, he mixes sand and dust in equal parts. He then takes two measures of the mixture of sand and dust, and one measure of lime after being tempered with water, and makes them into a heap. He then works them dry, moistening them little by little as they mingle. Lastly, they are taken to a trough, where they are beaten by rammers of wood armed with iron, which are suspended from the ends of poles acting with a spring, like the spring pole of a turner's lathe. Mr. Fleuret says the mortar is improved by wetting it in the trough with a little lime slaked thin, and used in the proportion of one-sixth of the mortar. He censures the practice of reworking the mortar with fresh portions of water, which he says weakens it much.

The author adds that hard stone pulverized, may be substituted for sand,

and that scoriæ, iron scales, and sea coal ashes, furnished by forges, are still better than pulverized stones and clay dust. These are, in brief, the means pointed out by M. Fleuret, for making the mortar he designs for factitious stones. The mortars being made after this process, they are placed in moulds where they are beaten and strongly compressed. Mr. Fleuret has made much use of factitious stone in making water conduits, pump tubes, troughs, &c.

Mr. Fleuret established a manufactory of factitious stones at Pont-a-Mousson. We might suppose that, having at his command the good hydraulic lime of Metz, he would obtain good results; but, as I have said, in the first section, when we attempted to apply this process to making factitious conduits at Phalsburg, and caps of arches at Landau and Strasburg—using the lime of the country, we did not succeed. What I have before stated shows that it is less the manipulation than the choice of materials which affords good mortar, and consequently good factitious stones. But Mr. Fleuret has not given us the means of ascertaining the quality of the materials: and it follows that in pursuing the path he has pointed out, we are exposed to bad results, as happened in the above cases.

According to the experiments I have made, the best process for making mortars to be used in forming factitious stones is, if we use hydraulic lime, to slake it to powder with about one quarter of its volume of water, and to cover it with the materials that are to be mixed with it. I have several times remarked on the importance of making the mortar soon after the slaking of the lime. We ought not therefore to slake more lime at one time, than will suffice for eight or ten days. If the lime be eminently hydraulic, sand only need be added; and, of sand, that which is fine should be much preferred. If only a mixed sand can be had, it should be passed through a fine sieve; if it be too coarse, it should be pulverized; and if it be earthy, it should be washed by the process I have given.

If the lime be only moderately hydraulic, it will be necessary to make the mortars by adding to the lime equal parts of clean fine sand and cement.

If we happen to be in a country where the only lime is fat lime, we have seen, by table No. XXXIII, that it is quite immaterial whether this lime be used as soon as it is burned, or after having been slaked for some time, to paste or powder. Care should be taken to use only hydraulic lime made of clay, which contained but little lime. The mortar will be made by mixing the lime with the quantities of clean fine sand and hydraulic cement which shall have been found by trial to be the proportion best suited to the lime. In general, the proportion of one part of fat lime measured in paste, to two, or two and a half, of the other ingredients, will afford a very good mortar. There will be no disadvantage in wetting the mortar sufficiently to cause it to work easily, nor in reworking the mortar with a little additional water, should it become too dry. An excess of trituration is useless; it is sufficient if all the materials be well mixed. All my experiments show that iron does not improve mortar. The scoriæ, and the ashes of forges should not therefore be used without our being satisfied before hand, by the means I have pointed out, that they are hydraulic.

When the hydraulic mortar of which the stones are to be formed, has been made as above, it should be placed in moulds, if the stones are to be of small dimensions, and should be loaded with weights, or submitted to heavy pressure, until it has acquired sufficient consistence to be withdrawn from the moulds without breaking. The stones are then to be deposited in a moist place for about one year.

When factitious stones are made for water conduits, or other objects that are to be buried under ground, there is no objection to using red cements, such as are generally made from brick earths; but this colour would be disagreeable to the eye; and in case the objects are to be exposed to view, cements derived from clays that do not take this colour from burning should be used; such, for example, as are used in making tobacco pipes, stone ware and crockery. With the same view, cement derived from slate may be used.

There is no doubt in my mind that with good mortar, factitious stones may be made which will afford, at the end of a year, a resistance approaching that of ordinary bricks, and that the strength will go on increasing with time. We find in the Annales de Chimie, Vol. XXXVII, that "Mr. Monge, in visiting the ruins of Cesaria, remarked, in a temple consecrated to Augustus, that the pillars had wasted away to a great depth, but that the mortar projected. He tried in vain to break off a piece. The mortar was of very fine and equal grain; it appeared to be composed of fine sand and very little lime, very well mixed." It has been remarked that in the ancient Roman constructions which still exist in the Northern districts, the mortar has perfectly resisted the inclemencies of the seasons. I made at Strasburg large cubes of hydraulic mortar, which I withdrew from the water after about one year, and left exposed to the air during several summers and winters without their sustaining any injury. In the 7th No. of the *Memorial de l'Officier du Genie*, it may be seen that I proposed in 1819, to cover with factitious stone the floor of a sluice *de chasse*, which was 100 feet wide and was composed of five passages. The foundation was of concrete, and it was covered with a layer eight inches thick of good hydraulic mortar, which became united to the concrete, formed a factitious stone, showing, the next year, great solidity. It has now been made ten years, and it has sustained no injury. This means may be used with great advantage in countries where there is no good stone for cutting, or where such stone is dear.

In countries where free stone is not to be obtained, it is very advantageous to be able to compose factitious stones to form the angles, copings, casements of doors and windows, cornices, gutters, water conduits, &c.; this mode of fabrication might even be applied advantageously to objects of the largest dimensions. It often happens that for bridges across the ditches of fortifications, pieces are needed of about three feet in thickness: where stones are not to be had of suitable quality, these pieces may be easily made on the spot in a single piece of factitious stone: under similar circumstances, piers of sluices, columns, and obelisks may, also, be made; but in the cases of such large masses, it will not be easy to bury them in the first instance, and afterwards place them in the proper situations. It will be best, therefore, to construct them on the spot. It does not seem to me to be indispensable to make plank moulds to give them their proper shape: forms such as are used to direct the construction of walls, would suffice. It would only be necessary to take care, when the mortar had been made of ordinary consistency, that it should stiffen a little before being used, so that on being spread with the trowel it would retain the form given it, and at the same time be so ductile as to spread easily and unite itself well with the previous layer. As this mortar dries very quickly, there is no danger that the work of the morning will give way under the pressure of that of the afternoon. After having finished the day's work, care should be taken to cover the top of the wall with wet straw matting, so as to maintain a favourable humidity; in the morning the surface of the mortar should be rammed with a small flat rammer, and be made slightly wet, so as to be somewhat softened and brought into proper state to unite with the succeeding layer. As the work rises, care must be taken to surround it with straw, or some similar substance, which must be kept always moist during the first summer. If the work have but little altitude, earth may be banked against it. In all constructions of this kind, it is proper to make the work with a little excess of dimensions, so that the following year some tenth of an inch of the outside, which, having dried too quickly, will be less hard than the interior, may be cut away; pressure should always be applied, in any way most convenient, where the nature of the structure will permit it.

If it be thought proper, these factitious stones may be coloured at the time they are made, by mixing in the mortar composing the surface, some suitable metallic oxide.

If the factitious stones are to be of large dimensions, gravel or small stones may then, for the sake of economy, be mixed with the mortar: in such cases the resulting mass will be concrete. This substance was used by the Romans: several of their works are found in which the faces of the walls are of stones, and all the interior of a mixture of mortar and pebbles. Mr. Fleuret having enumerated, as stated in the beginning of this chapter, the great monuments supposed to have been made of factitious stones, says "There are even great walls constituting the enclosure of towns, large aqueducts, and piers of bridges, still remaining, nearly entire, from the time of the Romans, of which the faces are made of very small stones, and the heart of the wall ot pebbles mixed with stones larger or smaller, thrown at hazard between these light facings. This masonry made of fragments, and rammed in an encasement, becomes but a single mass, and is rendered so compact by continuity, that in a short time the walls becomes indestructible."

I do not think that this masonry was made in encasements; the facing walls were substitutes therefor; and had there been no facings, the concrete, as I have before observed, might have been built up without moulds. But we see by the quotation, that the Romans made much use, in constructions in the air, of small materials mixed with their mortar, and it is this kind of construction which, as I have said, we now call concrete. I have stated, in the first section, that in repairing, in 1816, one of the dams which sustained the navigable canal of Strasburg in its passage across the ditches of the fortification, I found that the facings alone were of free stone, and that all the interior was of concrete, of great hardness, which led me to presume it had been made of hydraulic lime, and induced me to make researches, whereby I became possessed of the qualities of Obernai lime, and afterward of many other hydraulic limes in the neighbourhood.

In constructing with concrete the interior of baterdeau that have sufficient thickness, we may be certain of their great durability. In rubble or regular masonry, the mortar does not always unite itself perfectly to the stone—so that if there be a head of water, it will at least find a passage between the joints. This cannot happen in masonry made of small materials, as concrete, because all these small stones are separated from each other by a portion of the mortar which will oppose filtration. In the two baterdeaux of Strasburg which I have cited, the facings were displaced; but the central mass of concrete prevented a single drop of water from passing, notwithstanding the bad condition of the facings.

Mr. Rondelet says at page 116 of his work "There is found near Metz in France, a very hard stone with which they make lime of very superior quality; this lime, newly slaked and mixed with gravel, affords a concrete or species of mortar, of which the consistence is so great that arches may be constructed of it, without bricks or stones; these arches form a single piece as hard as stone.

Lieut. Col. Finot has constructed at Strasburg, within two years, an arch of concrete of about thirteen feet four inches diameter, which has succeeded well: the piers are of masonry. A similar arch has been coustructed at Schelestadt. This kind of arch offers great advantage in many circumstances.

When the arches are to be underground; this will be the best means of preventing filtration; but that the underground room may be perfectly dry it will be necessary to make the piers and end walls also of concrete.

It often happens that there are casemates and cellars which in time of floods, fill with water. This may be prevented by putting a structure of concrete upon the bottom: and if the water filters through the walls, by reinforcing them with a plaster of concrete. By these means we turned to profit, at Strasburg, several casemates, of which the floor was below the level of the water in the river, and in the ditches, in time of floods.

We are frequently obliged to carry a canal over a stream of water, and vice versa. In such cases aqueducts are built. It is here particularly, as in aqueducts in general, that concrete is indispensable. If it be thought proper to build the arches of stones or bricks, it is indispensable, in order to resist filtration, to make all the masonry above the arches, of concrete. In countries where proper materials for making the arches cannot be obtained at a reasonable rate, it will be advantageous to make the arches of concrete, in which case the aqueduct will be formed of a single piece. Arches of large dimensions may be constructed in this way, either for aqueducts or for ordinary bridges.

It is necessary sometimes to enlarge a wharf, in cases where the river cannot be restricted; and it is done by making all the courses of masonry, projecting, or corbel, courses—a very expensive construction, on account of the large dimensions which the stones must have. The same result may be obtained with concrete, which will form but a single piece of great solidity, at small comparative cost. By similar means *machicoulis*, which are sometimes necessary to protect the entrance to forts, may be made.

Researches are now being made as to the means of preserving grain in *Silos*. It is requisite to success, that the grain be preserved from the contact of the air, and from humidity. Both these conditions will be secured at the same time, by making the *Silos* of concrete. After the grain is deposited therein, it may be hermetically sealed by closing the mouth with the same substance. *Silos* may be of great advantage in provisioning fortified places: and it is important that attention be directed towards them.

In some departments in the north of France, no good building stones are to be found, and revetment walls are there constructed of fragments of chalk, there being a facing of bricks to preserve the chalk from contact of the air. But in several of these places the bricks are of bad quality, and this facing scales off, requiring considerable, and perpetual, outlays for repairs. In such circumstances it should be, I think, advantageous and economical, to build the revetment entirely of concrete. It should be composed of hydraulic mortar in which would be mixed gravel, fragments of chalk, bricks or any similar matters, in the proportions indicated in the first section. Taking care to apply on the outside a thick plaster of the same kind of mortar. The plaster should be applied at the time the concrete is laid, so that it may unite with it perfectly. By this means the chalk will be preserved from contact of air. As the wall rises, humid earth should be placed against the back of it, and the front should be covered with straw-mats or a thick layer of straw, which should be kept wet during all the first summer. In countries where good *arenes* are to be had, revetments in concrete would not be dear; and, besides the advantage of avoiding considerable expense in repairs, it would be more difficult to make breaches in revetments of concrete than in those constructed of stone.

I will observe that in the construction of revetments, which have, commonly, about thirty-three feet in height, and sustain a great mass of earth, the bad quality of the mortar often makes a much greater thickness of masonry necessary than if the mortar were good. By making, as I have proposed, all the masonry of hydraulic mortar, the expense will be augmented a little; but on the other hand it will be possible to diminish the thickness of the walls, which will be a compensation. By making the revetments of concrete they will be of a single piece, and the thickness may be sensibly reduced; which will amount to a great saving wherever good arenes are at hand. Nothing would prevent these revetments being made with counterforts or with relieving arches.

In the south of France particularly, are to be seen revetments of great exterior slope. This mode of construction, permits the thickness of masonry to be considerably reduced: but it cannot be adopted in the north, because of the humidity which favours the development of vegetation in the joints, causing the ruin of the masonry. By constructing these revetments with concrete, taking care to apply a strong exterior coat of plaster immediately, and to unite it perfectly with the beton, there will be nothing to fear from vegetation, and the talus of the wall will allow its thickness to be considerably lessened. This will be worthy of trial at those places in the north where the materials are not generally good, and where arenes are to be obtained.

When repairing revetments from which portions had scaled off, from the effect of vegetation, I had occasion to remark that sometimes the lime seemed to have disappeared from the mortar almost entirely; to such a degree that it was thought the lime had been fraudulently reduced in quantity in making the mortar. Examining these separated parts of the wall, I remarked that all the joints of the stones were filled with roots which had penetrated to a great depth. There remained hardly any thing but sand in the joints of the stones. I was led to believe from this that fat lime is absorbed by vegetation. I saw no such effect in masonry made of good hydraulic mortar. It is possible that the hardness of these mortars resists the development of vegetation; or that this kind of lime is less favourable than fat lime. In making revetments of concrete, giving them a good coat of plaster made of hydraulic mortar, of which the surface should be made very smooth, it seems to me that there would be nothing to fear from vegetation.

In the northern department of which I have spoken, the buildings are not more solid than the revetments. They are obliged to make them of bricks which are at the same time of bad quality and very dear. In many southern districts houses are made of *Pisé*. This kind of construction is not in my opinion solid enough for military establishments; and I doubt if it would succeed in the humid climate of the north: but I see nothing to prevent these buildings being made of concrete. I have shown that with hydraulic mortar we obtain a strength approaching that of common bricks. The walls of houses constructed of concrete containing this kind of mortar would possess great solidity, and wherever arenes were at command and building materials bad, would be erected with great comparative advantage. The angles of the building, and the casements of doors and windows, should be made of factitious stone, and the walls should be covered with a coat of hydraulic mortar, coloured to resemble stone. The precautions indicated above, against too rapid drying, should not be omitted. It would be easy to make a trial of this kind, on some small building, or a guard room, kitchen, &c.

We often have to construct bomb proof buildings, for powder magazines, barracks and other establishments. In countries where the mortars are of bad quality, I am of opinion that it would be wrong to make them of concrete. When made of stones, or bricks, I have already said, that it seems to me necessary to use hydraulic mortar. I will add that when it is thought proper to make the arches of stones or bricks, I regard as indispensable, after the centre has been struck, to make all the masonry above these arches of concrete; this being, in my opinion, the only means of securing their future impermeability. This mass of concrete might, in fact, enable us to dispense with a plastered cap; but, for greater security, it will be best to put on a coat of plaster of about one inch in thickness. It is very important when these caps are in progress, to shield them from the sun. They are sometimes covered with a sail cloth; but this does not preserve them from hot air which causes them to dry too quickly. It would be better and cheaper, to cover them, as they advance, with moistened straw. When the caps have acquired sufficient consistence, they should be polished, and again covered with straw, which should be kept moist all summer. If the arches are to be covered with earth, this earth, at least in part, should be put on as soon as the caps have been polished.

There is still another use to which concrete may be applied with great advantage, namely in the abutments of suspended bridges. When there is not rock to which to attach the chains, it is necessary to build abutments; but these chains acting in an angle of about 45°, a great part of the tension is in a horizontal direction. If the mass of the abutment is of cut stone; or rubble masonry, the mortar not fastening the stones together strongly, this force may disjoin them horizontally. This lately happened to the suspended bridge built opposite the *Invalids* at Paris. I do not doubt that the masses of masonry forming the abutments would have been competent to resist a much greater force than they were subject to, if those abutments had been of a single piece each: but as they were constructed of cut stone and rubble masonry, and there had not been time for the mortar to dry thoroughly, the masonry separated into two parts near the middle of the abutment, so that the hand might be introduced between them. This I consider the explanation of the accident which made it necessary to demolish the bridge before it had been entirely uncentered. If the masses to which the chains were fastened had been of concrete, they would have formed a single, homogeneous, inseparable mass: it would have been necessary for the chains to have drawn it off entirely, or to have broken it, while, in the actual case, it was only necessary to disjoin stones that had but recently been united by mortar. When bridges of this kind are built it seems to me proper to make the abutments, to which the chains are to be attached, of concrete: and they should be erected a year in advance so that the substance may acquire sufficient solidity.

The beginning of autumn is the most favorable season for making concretes that are to be exposed to the air.

I will conclude by observing that the expense necessary to the composition of good mortars for concretes, must be encountered. In countries where the arenes are not very hydraulic, they may be mixed with hydraulic cement in proportions depending on the energy of the materials. As I have said above, it is more economical to encounter the requisite expense of good masonry, at once, than to execute it cheaply of bad materials.

I have thought it proper to enter into some details as to the advantageous use to be made of concrete in places where building materials are of bad quality; and to indicate some new modes of construction to be substituted for those now in use.

### ARTICLE XVI.—*Summary of the Second Section.*

The experiments reported in the second section of this memoir, lead me to the following conclusions, as to mortars exposed in the air.

When I made mortar by using fat lime that had been lying slaked and moist for a considerable time, and sand only, I could obtain no satisfactory result, whatever were the proportions. In making mortars with sand, and fat lime just from the kiln, I could obtain only mediocre results. The lime I used was got from a carbonate of lime containing only a minute quantity of iron. It will be important to ascertain, whether, as I anticipate, similar results will be produced in other countries. Should the experiments in other places afford similar results, it will be necessary to abandon the practice of keeping fat limes lying slaked and wet for a long period, and to adopt that of using them fresh from the kiln.

The process of slaking lime announced by Mr. Lafaye, and that given by Mr. Loriot, afford no sensible amelioration with fat lime.

Hydraulic limes mixed with sand, produced very good mortars in the air, as well as in water. These limes must be used soon after the calcination, as they lose a great part of their energy. Mortars made of hydraulic limes afford a greater resistance when they are mixed with sand and hydraulic cement, than when mixed with sand only. Hydraulic cements, or other analogous matters, mixed with limes, restore the energy of those which had been too long exposed to the air; and augment the energy of those which are but moderately hydraulic.

Hydraulic mortars made of fat lime, sand, and hydraulic cements, or other analogous matters, are excellent when used in the air. When sand and cement, in equal parts, are added to lime, it is almost a matter of indifference whether the lime be used fresh from the kiln, or slaked to powder with a little water, and for some time exposed to the air in this state, or, having been slaked and lying wet for a considerable time. But if only a small quantity of cement is to be added to the mortar, it will be best to use the fat lime shortly after its calcination.

In countries where good natural hydraulic limes are to be had, they may be used with sand only, in making mortars for exposure to the air. When such limes are not to be found, instead of making artificial hydraulic limes, it will be preferable, as in the case of water mortars, to make the hydraulic mortar directly, by mixing fat lime with sand and hydraulic cement. The proportion of cement to be mixed in the mortar will depend on its quality, and the nature of the works to which it is to be applied.

Clay dust containing about one-fifth of lime appears to be less proper for mortars that are to be exposed to the air, than for those to be placed in water: but a few hundredths of lime, far from injuring, have an advantageous effect in saving fuel, and facilitating the pulverization of burnt clays. Clay dust, and other analogous matters, should always be made very fine.

*Arenes* mixed with fat lime afford hydraulic mortars, which are very good in the air. When the arenes are feeble, they should be mixed with a little hydraulic cement.

When *clay dust*, *ashes*, *scoriæ of forges*, and *arenes*, have only weak hydraulic properties, they give to air-mortars but feeble tenacity. Before using these matters in the air, therefore, they should be tried by mixing them with fat lime, and plunging them in water, according to the process given in the first section. It is the more important to make such trials, because these substances are very dear, and some varieties of them produce no better effect than so much sand.

Fat lime and hydraulic lime do not seem able to bear as much sand as is commonly thought. Fine sand affords much better results than coarse, both in air-mortars and in water-mortars. Earthy sands must be avoided. In places where earthy sands, only, can be procured, they must be washed: but before resorting to this operation, we should be satisfied that these sands are not arenes. Should they prove to be arenes, they must be used in the state in which they are found.

The process given in the first section for the manipulation of water-mortars applies equally to air-mortars. No ill consequences need be apprehended from wetting the mortars to the degree requisite to their being worked with ease; nor, when they have become too stiff, from exposure to the air, from adding a little water, on reworking them. An excess of trituration, beyond what is required to mix the ingredients thoroughly, is altogether useless.

It does not appear that the Romans had any particular process for making their mortars. No masonry has survived to our day but such as was made of hydraulic lime, or of fat lime and hydraulic cements, or arenes (I speak here of masonry made of small materials.) An inspection of their mortars shows that they were often made with little care, proving that their good quality is to be attributed solely to the quality of the lime, or of the substances mixed with it.

If, in general, no better results are obtained with fat lime, than those obtained by me, the practice of making mortars of fat lime and sand only, should be abandoned. A small quantity of hydraulic cement, or of some substance of similar nature, should always be mixed in the mortar; that is to say, all air-mortars should be hydraulic mortars. The expense will be a little greater it is true, but there will be full compensation in the duration of the masonry. There is no economy in putting up cheap masonry which will require to be rebuilt at the end of a few years; and will need costly repairs, annually: it is much better, and really more economical, to encounter, at once, the expense which will secure to the work an indefinite duration, and exemption from all but trivial repairs.

Hydraulic mortars, whether made of hydraulic lime and sand, or of fat lime and hydraulic cement, or other similar substance, resist the inclemences of the seasons well, which makes them proper to form factitious stones. The art of making factitious stones is nothing more than the art of making good hydraulic mortars. This kind of stone may be easily made to possess, at the end of a year, a tenacity about equal to that of ordinary bricks, and this tenacity will go on augmenting, for several years. The solidity of hydraulic mortars is favoured, and of course the solidity of factitious stones also, by keeping them moist during the first year. They should, therefore, be buried under ground, or placed in water, if their dimensions will allow; and when too large to be thus disposed of, they should be formed on the spot they are to occupy, and be enveloped in some material which may be kept wet. It would be proper to make their dimensions a little in excess, in order to bring them, subsequently, to their true dimensions, by cutting away the surface that had been in contact with the air. In order to avoid disagreeable colours, cements should be taken, which are but little coloured by the oxide of iron.

In countries where building materials are of bad quality, and where energetic arenes, or good hydraulic limes, are to be had, concrete may be advantageously employed, in the construction of revetments, underground rooms, aqueducts, and various buildings: this mode may also be employed, even where no arenes or hydraulic limes are to be found, provided the materials for making cements, can be procured at a moderate price.

It will be important, wherever works in masonry are to be carried on, to make experiments in order to ascertain, 1st, the quality of the several kinds of lime to be found in the neighbourhood; 2nd, whether it be best to use fat lime fresh from the kiln, or to slake it into vats, and allow it to lie for some time wet, as is commonly done; 3rd, the proportion of sand that gives the best mortar; and 4th, the quality of various arenes and cements to be found in the vicinity.

To make these various experiments, both for water-mortars and air-mortars, I think the essays should be submitted to trial, after about one year, with a machine like that used by me, and of which a drawing is added. It would be advantageous to make, in all places, the trials with prisms of mortar of the same dimensions, in order to compare the various results, and to ascertain the relative qualities of the materials, in different districts or countries. The great number of experiments I had to make, was the reason why I used prisms too small. I think that quadrangular prisms 14 inches long by 4 inches, (0.35m × 0.10m × 0.10m) would be of suitable size.

To this end the mortar should be moulded in boxes 14 inches long by 4.80 in. wide by 4.80 high: after a year, four-tenths of an inch should be cut from each face, and the prism be placed in two stirrups of iron, like those in the plate—the stirrups being twelve inches clear distance apart, and be broken in the manner pointed out in the first section. Similar prisms should be made of the best brick earth in the vicinity, which, after being burned, should be cut down to the same dimensions as the mortar prisms; these brick prisms being broken, the average weight sustained by them will serve to appreciate the resistance of the mortar prisms. Stone prisms should also be subjected to the same trial: these, when of good stone, will show a strength much beyond that of the best bricks: I doubt if mortars can be brought to afford a resistance equal to hard stone: but the strength of bricks may be easily attained, and that will give good masonry.

I must urge upon Engineers to study, in their several localities, the meterials most proper to make good mortars. The fabrication of mortars has been, for a long period, abandoned to a routine which has produced perishable masonry, requiring frequent repairs; and thus consuming funds which might have been applied to the construction of new work or the amelioracion of the old. Engineers should not consider it beneath them to be occupied in this kind of research: and they should leave behind them at each place, a relation of the experiments they have made, and the results they have obtained. These operations require minute attention, certainly, but this will be recompenced by works of long duration.

(TO BE CONTINUED.)

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FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

## *Mechanical power of the Pulley; in reply to the strictures signed G.*

By L. H. Parsons.

Accompanying my essay on the "Mechanical power of the Pulley," in the October number of the Journal of the Franklin Institute, is an article, signed G, in which the writer assumes and professes to show, that I "labour under some misapprehensions" in supposing that the *movable pulley* is referable to the second kind of lever. The remarks are of such a character as appear to me to call for, and I presume I shall be allowed, a few words in reply.

After intimating that my piece was inserted as a matter of sufferance, the writer complains of the want of clearness in the expression of my views. I certainly regret that I failed of making my views intelligible,—for I cannot but flatter myself that the writer of the article, as well as every other reader, would, if he had understood my reasoning and illustrations, have agreed with me. I regret also, that he did not point out the passages, containing the obscurity of which he complains; so as to give me an opportunity, if possible, of making the matter clear.

At present, I do not feel called upon, or even at liberty, to attempt any further exposition or defence of the principle which I undertook to establish:—for my reasoning has not been answered, or even a single point alluded to by G. Whether sound or fallacious, the whole of it remains untouched. I attempted to show that a *movable pulley*, connected at one side with a stationary cord, and at the other, with the power, operates upon the principle of a lever of the second kind; also, that the same holds true with a cord passing over a solid body *without* a pulley. Instead of pointing out any fallacy in my reasoning, or, in any way, showing that a real pulley *does not* act upon that principle, G. supposes an "imaginary machine," in which, to use his own language, "the points considered as the points of application of the power and weight respectively, *coincide!* and of course, move through equal distances, in equal times," and concludes that "here there is no lever." Very true; and what is there, I ask, in this "imaginary machine" that can claim any resemblance, even in theory, to that known by the name of the pulley? I must confess that I can discover nothing. If the points referred to, *coincide*, and coincide they must by the supposition, the machine (if it be called one) is neither more nor less than a single line attached to a weight. Consequently, no reasoning in regard to it, has any thing to do with the subject in hand. If by supposing all the parts of the machine to be reduced to a single mathematical point, it can be shown that the *pulley* is not a lever, then by the same process, it can be proved that the *lever itself* is not a lever. Instead of "an infinitely fine wire," why might I not as well suppose an infinitely short bar or rod, and then say that "here there is no lever, since the points before considered, as the points of application of the power and weight (and fulcrum also) respectively, now coincide, and of course, move through equal distances in equal times."

For myself, I can conceive of no use in thus refining the matter down to an infinitesimal, even if the supposition did not destroy, or affect, the essential elements of the machine; which, however, it certainly does, in the case before us. Why not suppose a real, or at least a possible machine? Suppose a real bar (I care not how short, provided it has sufficient length to admit of a point lying half way between the two ends, and not *coinciding* with them) with one end suspended by an immovable cord, and the other by one that is movable, or by the hand; and then suppose a weight to be attached to the centre of this bar; (see the bar A, C, in the diagram, page 244) will G. say that "*here* there is no lever? "If not, will, or can any difference be pointed out between it and the movable pulley? If G. will procure (as I have done for the purpose of experimental illustration before a class) a pulley, five or six inches in diameter, with a straight bar of similar length, attached to its side, the centre pivot passing through both the bar and the pulley, and the apparatus so constructed that the cord may easily be removed from the edge of the pulley and attached to the ends of the bar, I have no doubt he will admit the existence of the principle in question.

G. says, "several authors have explained the relation between the power and the weight in the single movable pulley, on the principle of a lever of the second kind. I am aware that some authors have spoken of it in general terms, as being a lever; but I had supposed that the stumbling block always consisted in neglecting to transfer the fulcrum from the centre to the periphery of the pulley. I should be glad to be referred to an author who expressly assigns the fulcrum to the point where the stationary cord comes in contact with the pulley.

Not long since, I received a communication (in reply to some suggestions of mine on this subject) from a learned Professor, who is the author of a valuable and popular treatise on Natural Philosophy, in which he explains the pulley in the usual way. He expressly admits that "the movable pulley is a lever of the second kind, where the power is applied twice as far as the weight from the fulcrum;" but he does not consider the matter of sufficient importance to call for any change in the rationale. For my part, I think truth should be preferred to error, even in the most trifling matters, especially in Philosophy; and even though old associations and the sanction of great names, be on the side of error. But a subject, involving a fundamental principle in Mechanics, cannot be considered trifling.

Having pointed out what I conceived to be the irrelevancy and unsoundness of G's. strictures, I have now in conclusion, only to say that I am willing to leave the argument, just as it is, in the hands of my readers, with this single request—that they re-examine, carefully, the two articles, to which this communication has reference. Let the enquiry commence, (where it ought,) with the thing itself, a real machine, instead of that which has no actual resemblance to it, a non-entity, and I have no fear for the result. If any defect can be detected in my reasoning, or any unfairness in my illustrations, I expect and desire it to be exposed.

November, 1837.

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*Remarks.*—The foregoing communication, from some cause unknown, was not received at the Institute till it was too late for insertion in the last number. Whatever may have been the impression produced by the observations on the former paper of Mr. Parsons, certainly nothing more was intended than an attempt to rectify what was conceived to be "some misapprehensions" into which he, in connexion with many others, have fallen with regard to the best mode of reasoning in demonstrating the theory of the pulley. The question at issue is considered as worthy of philosophical discussion, and the writer of these remarks does not doubt from the last sentence of Mr. Parson's communication, that, as an instructor, having a high regard for the truths of science, he will duly appreciate every attempt, fairly designed, to render those truths triumphant.

The want of clearness to which allusion was made, occurs in the second paragraph of page 244, in which it is asserted that the cords, though " practically indispensable," are not " theoretically, an essential element." It is doubtful whether the author means to convey the opinion that an elementary notion of a pulley could be given to a pupil without the supposition of a determinate *flexible* connexion between the two points to which he wishes principally to direct the attention, viz: the two extremities of his lever. How the fulcrum of the straight bar which (as he states above) he attached to his pulley, was made to ascend, during the experiment, he does not inform us. If it truly represent any given diameter of the pulley while in motion, it must necessarily descend, and without a constant downward motion of the imaginary fulcrum, no motion of the weight could ensue. But is not a constant motion of the fulcrum inconsistent with the *elementary* notion of a lever? If the weight *constantly* rise, what is the " time being" during which the fulcrum is " vertically stationary?" To make out a case, therefore, it seems that he has at last to come to " infinitesimals," and this appears at least as objectionable with respect to time, as to space or distance.

If it be alleged that a constant movement of the fulcrum is not incompatible with the definition of a lever, provided the motion of the weight and the power be relatively more rapid, as in the rowing of a boat, I would still urge, that as a dynamical machine, the oar would be *more* effective were the fulcra fixed points, as they might be were the boat in a canal so narrow that the oars could reach the shores, and lodge at every stroke against a fixed obstacle; and that just in *proportion* to this stability is the oar to be considered as a lever of the second kind, and no farther. The idea of a *perfectly* unstable fulcrum seems to me to divest the lever of the attribute of power, and that an imaginary condition of simple statistical equilibrium is an insufficient postulate as a basis of reasoning in a case like the present.

But the error (if it be one) of considering the movable pulley as a lever of the second kind is not peculiar to Mr. Parsons. As he wishes a reference to authors that have so considered it, I quote a few of those which happen to be at hand, merely changing the letters in their references to figures, to suit the one given by him in his first communication in the last Vol. page 244.

" The movable pulley is fixed to the weight W, and rises and falls with it. In comparing this to a lever, the fulcrum must be considered as at C; the weight acts upon the centre D, and the power is at the extremity of the lever A. The power, therefore, being twice as far from the fulcrum as the weight is, the proportion between the power and the weight, in order to balance each other, must be as 1 to 2."—*Imison, Elements of Science and Arts, Vol. I, p.* 51.

" We have now to show that the movable pulley acts like a lever of the second order. Let the movable pulley be fixed to the weight W, with which it rises and falls. In comparing it with the lever alluded to, the fulcrum must be considered as at C; the weight acts upon the centre D, by means of the neck D H; the power is applied at A, and the line A C will represent the lever."—*Smith's Panorama of Science and Art, Vol. I, p.* 308.

"Maintenant la droite A C peut etre considerée comme un lévier du deuxième genre; son point d'appui est en C, la puissance est censée agir en A, et la résistance se fait sentir en D dans le sens vertical D H."—*Mollet, Mécanique Physique, p.* 366.

"When used in this manner, (the fixed pulley,) the pulley is but a method of altering the direction of the applied force. But if inverted, so that the end of the line E is attached to a fixed point, the weight or resistance being at D, and the applied force acting upwards, the line from E being permanently fixed, it will become a fulcrum; and the horizontal radii of the circle assume the position of a lever of the second class," &c.—*Nicholson's Operative Mechanic, Phil. edit. p.* 11.

"A C represents a lever of the second kind, whose support is at C, a fixed point; the rope C E being fixed at E. And the weight W acting at the middle of A C, and the power acting at A, twice the distance from C; therefore the power P is to the weight W as $\frac{1}{2}$ A C to A C; or as 1 to 2."—*Emerson's Works, Vol. VII.*

"This power (the pulley) may likewise be explained on the principle of the lever. If the pulley is fixed, it is a lever of the first kind; if movable, it is one of the second kind.

"In the movable pulley the power is applied at A, the weight at D, and the fulcrum is at C; therefore since the length of the arm A C is double that of D C, a power P applied at A will sustain a weight W applied at D twice as great as P."—*Willit and Smith's, Elementary Treatise on Nat. Phil. Philad.* 1830, *p.* 44.

In conclusion I cannot but agree with the author of the treatise on mechanics in the "Library of Useful Knowledge," "that such investigations (establishing the conditions of equilibrium by considering it as a lever) are founded on wrong principles, although their results happen to be true;"—and with Dr, Gregory in his treatise on mechanics, Vol. I, p. 88; who states, with approbation, that "Professor Hamilton and others have been of opinion that the pulley cannot properly be considered as a lever of any kind."

G.

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For the Journal of the Franklin Institute.

## *Result of some experiments on Temperature, connected with the use of Prof. Olmsted's Stove. By* J. Griscom.

Since the introduction of anthracite coal as one of the main sources of domestic heat in a large section of the United States, the number and variety of contrivances for facilitating its combustion are scarcely less amusing, than were the numerous determinations of its total unfitness for the purposes of a common fuel, and the numerous grates that were pulled down, after giving it, as was supposed, a fair trial. The success which has since attended the use of this material, the demonstration of its admirable adaptation to all the wants of the parlour, the bed room, and the kitchen,—its extensive employment in manufactories, and the vast enterprise now manifested in the exploration and transportation of it, are flattering evidences of the skill and energy with which obstacles are overcome by our citizens, and the bounties of nature, so lavished upon our country, turned into the channels of its prosperity.

No species of fuel hitherto tried by man, of equal calorific power, can be compared with the anthracite of Pennsylvania, for the combined qualities of cleanliness, durability, and economy of time and money. The recent application of it to the reduction of iron ore, seems to form a climax in the discovery of its beneficial qualities. But we know of no fuel which requires so much judgment in the proper management of it. Its great compactness demands a nice regulation of the draught, and admission of the air requisite to maintain its free combustion.

For the purpose of saving fuel, and consequently the labour and trouble of attendance, stoves are preferable to open grates. They are also much more effectual in keeping up the temperature needful to entire comfort in cold weather. In a properly constructed stove, no heat is absolutely lost, for no more need be allowed to escape into the chimney than is necessary to support the warmth of a column of air a few degrees above that of the external atmosphere, in order to produce a sufficient draught. The equable diffusion of heat throughout an apartment, is best accomplished by a spreading jet, or column of heated air, and when this can be combined with the operation of a stove, it is difficult to perceive, so far as the production and diffusion of heat are concerned, what further improvement is to be expected.

Without pretending to much practical information relative to the numerous modifications, patented or not patented, which have been given to stoves for the purpose of burning anthracite, I would state, that having occasion to make a selection, I resolved to try the stove of Professor Olmsted, not with a view to assert its superiority, but by a register of its effects, to furnish data from which any one may draw conclusions satisfactory to himself.

My room, which is used both as a study and a sleeping room, is about eighteen feet square. The house is situated on elevated ground, between nine and ten miles from Philadelphia, on the Columbia Railroad. The stove, or furnace, is a cylinder of Russia sheet iron, lined with fire brick. The internal diameter is eight inches, and the height of the cylinder from the floor is two feet seven inches. It stands two feet nine inches from the chimney, the pipe passing through the chimney board of a small fireplace. The stove is connected laterally, with a double cylinder or drum, of similar sheet iron, into which the draught is turned as soon as the fire is well kindled, by closing a damper in the pipe. This drum or radiator, together with the pipe, increases the area of heated surface, in addition to that of the stove or furnace, to about eighteen square feet. The thermometer in the room hangs against a partition wall at the distance of about twelve feet from the stove, and four and a half from the floor. This was regularly compared (in the following table) with a thermometer in a northern exposure on the out side of the house.

| Date 1838. | External Thermometer. | | | Internal Thermometer | | | Pounds of coal consumed. |
|---|---|---|---|---|---|---|---|
| | Morn. | Midday. | Even. | Morn. | Midday. | Even. | |
| | Degs. | Degs. | Degs. | Degs. | Degs. | | lbs. |
| Feb. 11 | 19 | | | 62 | | | |
| 12 | 26 | | | | 66 | | 30 |
| 13 | 25 | | | 50 | | | 30 |
| 14 | 21 | | | 57 | | | 31 |
| 15 | 10 | 18 | 15 | 56 | 63 | 64 | |
| 16 | 20 | 20 | 19 | 46 | 60 | 60 | 30 |
| 17 | 8 | 18 | 14 | 44 | 62 | 64 | 32½ |
| 18 | 14 | 24 | 20 | 43 | 65 | 64 | 34 |
| 19 | 24 | 28 | 17 | 45 | 68 | 66 | 31½ |
| 20 | 15 | 22 | 10 | 45 | 70 | 66 | 32 |
| 21 | 3½ | 18 | 12 | 43 | 68 | 64 | 31 |
| 22 | 9 | 26 | 16 | 55 | 68 | 62 | 32½ |
| 23 | 14 | 26 | 24 | 52 | 66 | 64 | |
| 24 | 18 | 22 | 12 | 58 | 70 | 68 | 31½ |
| 25 | 6 | 18 | 12 | 54 | 72 | 66 | 31½ |
| 26 | 7 | 26 | 11 | 45 | 66 | 70 | 31 |
| 27 | 11 | 32 | 18 | 52 | 67 | 68 | 30 |
| 28 | 8 | 24 | 24 | 49 | 74 | 62 | 31 |
| March 1 | 13 | | 24 | 49 | | 66 | 32 |
| 2 | 20 | 32 | 22 | 56 | 66 | 70 | |
| 3 | 15 | 35 | 22 | 49 | 66 | 66 | 32 |
| 4 | 18 | 40 | 26 | 49 | 72 | 66 | 32½ |
| 5 | 32 | 44 | 36 | 55 | 69 | 71 | |
| 6 | 34 | 48 | 37 | 53 | 66 | 66 | 34½ |
| 7 | 32 | 36 | 33 | 56 | 69 | 72 | 33 |
| 8 | 32 | 33 | 32 | 53 | 66 | 69 | |
| 9 | 32 | 46 | 34 | 57 | 64 | 66 | 32 |
| 10 | 33 | 48 | 37 | 57 | 67 | 66 | |
| 11 | 32 | 48 | 38 | 57 | 66 | 68 | 31 |
| 12 | 34 | 52 | 40 | 56 | 69 | 66 | |
| 13 | 32 | 56 | 36 | 56 | 65 | 65 | |

Average temperature during the 31 days—

| | | |
|---|---|---|
| Out of doors, | | |
| | Morning | 19.9 |
| | Midday | 32.3 |
| | Evening | 25.5 |
| In the room, | | |
| | Morning | 51. |
| | Midday | 65.8 |
| | Evening | 66.1 |

Average quantity of coal consumed per day, 21.42 lbs.

Average coal consumed per day during the last nine days, when the external thermometer was nearly at the freezing point every morning, 14.4 lbs.

Average consumption the first 22 days, when the thermometer was constantly below freezing, 24.2 lbs. per diem.

It thus appears that estimating the stove to be in action during five months, or 150 days, commencing with the first of November, and ending with the last of April, the quantity of coal required, when the external thermometer averaged 20° of Farenheit, would be 3213 lbs., or less than a ton and a half; that if the range of the thermometer during the winter should average 32° (the freezing point) the quantity required would be less than a ton;—that the weather must be severely cold to require a rate of combustion exceeding a ton and a half;—and that this quantity would be sufficient to maintain the temperature of a room 18 feet square, at 60° during the night, and at 66° during the day.

But there are two other advantages in the construction which Professor Olmsted has adopted. *First*, By increasing the extent of heated surface, so as to prevent the iron from ever becoming so hot as to lose its polish by oxidation, and thereby not only to become, itself, rapidly deteriorated, but also greatly to injure the quality of the air. *Second*, The cold air which enters the room, and necessarily forms the lower stratum, flows towards the stove, and ascending in the open and heated cylinder of the radiator, forms a rising column of warm air, which, by its diffusion, produces a mild, summer heat throughout the chamber, rendering unnecessary the evaporation of water to counteract the usual deleterious effects of a hot stove. I found, on one occasion, the temperature of the air in this heated column to be 150°, while at the same time the thermometer, with its bulb resting on the last joint of the stove pipe, sunk to 110°, the thermometer in the room being then 70°, and outside of the house 36°. Both the furnace and the radiator may be too hot to be endured by the hand, while the end of the pipe remains barely warm.

It was no part of the design of this trial to furnish a laboured eulogium of the particular kind of stove in question. There may be other forms which would produce similar results. I can only say that I know of none. But in the use of any close stove for burning anthracite, care must be taken, by a due regulation of the draught, to prevent the escape into the room of the gases which arise from combustion. The truth is, that, heat a room as we may, and especially a bed room, the air must be gradually and constantly renovated to prevent deterioration, and to preserve it in a state perfectly fit for free and healthful respiration. Hence the great importance of good ventilation. This, in the case above described, was effected by leaving open, as occasion required, a hole made for a stove pipe near the ceiling, and opening into an adjoining flue of the chimney. By these precautions I slept constantly in the room during the experiment, with the door shut, without any inconvenience, except having to rise once or twice to open the ventilator, when it had been left closed on going to bed. Such an opening into a chimney can be easily regulated by a sliding valve, and ought (unless there be some equivalent) to form an appendage to every close sleeping room.

## Progress of Physical Science.

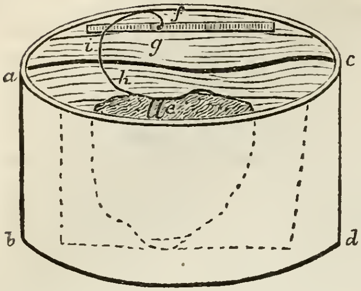
### *Origin of Mineral Veins.*

Extract of a letter from Robert Were Fox, Esq. to J. Griscom.

Falmouth, 11 mo. 30th, 1837.

"My theoretical views relative to the origin of mineral veins, have derived strong confirmation from some of my subsequent experiments, one of which I will refer to, because it bears on the symmetrical structure of sedimentary rocks. On exposing clay which had been pulverised, and afterwards moistened with acidulated water and worked up into a plastic state, to long continued voltaic action, it assumed the *laminated* appearance of clay slate.

Let *a*, *b*, *c*, *d*, represent an earthenware vessel, *e* copper pyrites, and *f*, a plate of zinc, connected by a copper wire *e*, and separated by a wall of clay, *a*, *c*, *g*, *h*, the copper and zinc cells having been filled with acidulated water. An apparatus thus prepared was set aside for some months, till the clay had become dry, and on its being taken out of the vessel, it separated into portions as indicated by the parting line *a*, *c*, each portion having *laminæ* in the same direction, shown by the finer lines, so as to give the whole mass a schistose appearance. A second experiment indicated precisely the same phenomena.



It is evident that the divided portions of clay *g* and *h*, were, like the metallic bodies, in opposite states of electricity, and one of them, consequently, in a more favourable state than the other, for the deposition of metals &c. from their solutions. This is precisely the reason which I have ventured to assign for metals being found in some rocks, in preference to others, and this often depending more on the *positions* of the rocks, or strata, with respect to each other, than on their natures merely; the numerous lamina in the clay also show that a series of pores may be formed in earthy matter, and serve to explain why insulated portions of metals, copper and the oxide of that metal, for instance, occur in masses of clay which have been long submitted to voltaic action after they have been moistened with a solution of the sulphate of copper.

The experiments I have referred to, seem to bear directly on the cause of the lamination and structure of rocks, and we may perhaps be enabled to infer from their lamina, the direction in which the electricity has principally acted upon them, its influence having apparently been greater on the more heterogeneous sedimentary rocks, than on the more homogeneous ones, in which molecular attraction seems to have predominated.

I send a polytechnic report for 1834, containing a description of my dipping needle, although some improvements have been made since this account was published.

This instrument has been used by Lieut. Burnett, at sea, on his voyage with Sir John Franklin, to Van Dieman's Land; the results thus obtained, are highly interesting, and he has sent a very satisfactory report of its performance.

I have also received most favorable and unqualified reports, of a similar instrument sent on Capt. Back's expedition towards the N. W passage; and of another which accompanied Colonel Chesney on the Euphrates.

I mention these facts as they may induce one of your Institutions to have one of these instruments.

They are made by Thos. Jordan of this town, who has supplied the admiralty and ordnance Boards with them for observations at sea, and on land, and I believe that no one in England makes them so well, or at so cheap a rate, his price is from £14 14*s* to £30, according to circumstances; the lower priced ones are not calculated for observations on the magnetic variations, but will answer perfectly for the dip and intensity."

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

## *Notice of three specimens of Garnet.* *By* THOMAS ELDER, JR.

1st. *Melanite.*—The chief localities of the black garnet, or melanite, hitherto known, have been Vesuvius, where it is imbedded in lava, and near Rome. Specimens of the same have lately been found on the Round Top mountain, about a quarter of a mile N. E. of Hummelstown, Dauphin county, Pa., in a trappean rock belonging to the range of the Conewago hills. The crystals are very distinct, presenting the usual dodecahedral form of garnet, with their edges sometimes replaced by a plane, and are therefore a combination of the dodecahedron with the icosatetrahedron. They are generally of a rich velvet black colour, opake, and with a resplendent lustre; a few, however, are greenish brown and translucent on the edges. The irregularities of their cleavage distinguish them from other varieties of garnet.

2d. *Cinnamon Stone.*—This beautiful mineral from Ceylon, has long been known and classed with the garnet from its chemical composition, its crystalline form having never been observed. I lately saw a specimen obtained from Mr. Nuttall, found on the line between New Jersey and New York, which is well worthy of particular notice, in consequence of its form. The crystals are remarkably distinct, with the brilliant surfaces and sharp edges of the dodecahedron, which in most cases are replaced by planes, and in a few instances the edges of this new plane are replaced by minute faces. They present, therefore, a combination of the dodecahedron and icosatetrahedron, with small planes of the hexaicositetrahedron. The lustre is more brilliant than that of the precious garnet, and the colour much lighter than the cinnamon stone from Ceylon, while the well formed crystals are nearly transparent. Experiments by the blowpipe prove that the quantity of iron present is smaller than is found in any other variety of garnet, excepting the Grossular.

3d. *Colophonite.*—This mineral is generally found in the form of irregular coarse grains, aggregated together; but I lately saw a specimen distinctly crystalized and presenting an unusual combination. It has the form of trapezoidal garnet, (icositetrahedron,) but where the faces of the dodecahedron should appear, may be observed a low four sided pyramid, which would make a solid of $12 \times 4 = 48$ planes. It is therefore a combination of the icositetrahedron with the hexaicositetrahedron, and without a single plane of the dodecahedron,—a combination of very rare occurrence, excepting in the diamond.

Philadelphia, January 27, 1838.

Melanites rivaling in beauty those of Frascati, have been found at Franklin, New Jersey. They have also been found at Germantown. An analysis of the Franklin Melanite was made by Henry Seybert, and published in Silliman's Journal, Vol. VIII, p. 300. G.

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# **Franklin Institute.**

## *Committee on Science and the Arts.*

At a stated meeting of the committee on Science and the Arts, held April 15th, 1837, a circular letter from the Hon. Levi Woodbury, Secretary of the Treasury, was received, proposing inquiries on the subject of a system of Telegraphs for the United States, and

At a special meeting held on the 18th of the same month, the following report was read and adopted.

*Report on Telegraphs for the United States.*

The committee on Science and the Arts, constituted by the Franklin Institute of the State of Pennsylvania, for the promotion of the Mechanic arts, to whom was referred the communication of the Secretary of the Treasury on the subject of telegraphs, think it would be premature, if not impracticable, to enter, at present, into minute details as to the matter referred to them, and judge that the Institute would fulfil the wishes of the Secretary more effectually by making to him an early communication of their general views, and leaving to a future correspondence any further developments that may be required of them. It is under this impression that the committee have hastened to prepare the following report:

1. *Kind of Telegraphs.*—The ample details given in Rees's Cyclopedia and other works as to the different schemes employed or proposed for telegraphs, render a description by the committee unnecessary. Only one of these telegraphs seems to have stood the test of long experience: it is that invented by Chappe, and employed in France since the year 1793. It is composed of three arms: one about eight feet long, movable around its middle point; and two of half the length, attached by their ends to the ends of the first, and also movable; the movements being communicated, from within the building, by cords and pullies. This telegraph is capable of giving one hundred distinct signals. It is believed, however, to be unnecessarily complicated, and has the disadvantage of not being suited for night signals.

The committee are, therefore, disposed to recommend a much more simple instrument, nearly similar to one lately introduced by M. Chateau, in a line of telegraphs which the Russian Government is erecting between Petersburg and Warsaw, and which is described in a late number of the Petersburg Transactions, by M. Parrot, together with a scheme of his own, almost identical with it, on which he had made successful experiments many years before.

This proposed telegraph consists of a single arm, or *indicator*, which should be about nine feet long and one foot wide, with a cross-piece at one end, about three feet long and one wide; the whole arm being movable about an axis at its centre. The arms are formed like Venetian shutters, and are painted a dead black: the apparatus and fixtures about it being white.

The movements may be communicated with ease and certainty, either by an endless chain passing over a wheel on the axis, and a wheel in the building; or by bevil wheels on the axis, and on a vertical bar passing from the building; or by a cog-wheel on the axis, and an endless screw on a vertical bar.

For night signals, three lamps are used: one swinging beyond the end of the arm; the other two beyond the ends of the cross-pieces.

2. *The Signals.*—The signals are given by the different positions of the arm of the telegraph. M. Chateau used only eight, but M. Parrot, by experiments in which the Emperor Alexander was an observer, de-

monstrated that twelve positions, distant 30° apart, could be readily distinguished. By an appendage (which will be proposed) to the telescope, all doubt on this subject will be removed.

Now it is believed that twelve fixed signals, together with those which may be given by certain motions of the arm, are abundantly sufficient for all telegraphic communications, whether alphabetical or numerical.

For this purpose, let the twelve different positions represent the following numbers and letters:

| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *a* | *b* | *c* | *d* | *e* | *f* | *g* | *i* | *l* | *m* | *o* | *s* |
|  | *p* | *k* | *t* |  | *v* | *j* | *y* | *r* | *n* | *u* | *x* |
|  | *ph* | *q* | *th* |  | *w* |  |  |  |  |  | *z* |
|  |  | *ch* |  |  | *wh* |  |  |  |  |  | *sh* |

The *h*, being only an aspirate, is omitted.

To indicate the separation of words, the arm may be vibrated twice, namely, one space (30°) to the right, and one to the left of the signal, and then carried to the first letter of the following word. To repeat a letter, the arm may be turned a space to the right, and then immediately brought back to the first position. To indicate that signals of numbers are to be given, the arm may be turned to the right, entirely round, and as much farther as may be necessary to carry it to the position 10, which is the 0 of numerical signals. To separate numbers, the same sign may be used as for separating words. To indicate that the signals of numbers are completed, the arm may be made to revolve entirely round to the left. When a wrong signal is given, the fact may be indicated by moving the arm backward and forward once, a distance of 90°, &c.

Suppose, now, the following signals to be seen and noted down.

4, 5—5, 10, 10, 5, 10, 8—1, 12—9, 1, 10, 4, 5, 4—1, 4—2, 1, 9, 4, 8, 10, 11, 9, 5—6, 8, 4—ɔ17,000c—10, 5, 10.

Taking the upper letters of the key, the despatch would be as follows:

De emmemi as lamded ad Baldimole, fid 17,000 mem;

Of which the true reading may be seen, even without the further aid of the key, to be this:

The enemy has landed at Baltimore with 17,000 men.

To prevent the discovery of the key, it may, when secrecy is important, be changed from time to time, without difficulty or inconvenience, since it is only at the extreme stations that it need be known.

If the system of signals, by a telegraphic vocabulary, be found most desirable, it will only be necessary to use the telegraph to indicate the numbers corresponding to the words in the vocabulary. In this way, if the ordinary decimal notation be employed, 999 words may be indicated without any one requiring more than three signals, 9,999 without more than four. But if the duodecimal notation be used, 1,463 words may be indicated without exceeding three signals for each, and 16,104 without exceeding four.

3. *The telescopes.*—For the telescopes to be used, M. Parrot recommends an achromatic object-glass of 3 inches diameter and 3 feet focal distance, and a double concave eye-glass of an inch and a half foca

distance. This is, in fact, a Galilean telescope, of the simplest construction, and will have a magnifying power of 30. The inconvenience of a very small field of view is of no consequence in this case; and the property of giving an erect image, with but two glasses, is perhaps of some importance.

Still the committee are disposed to give the preference to the common astronomical telescope, which has only the inconvenience (if it be one) of inverting the image, and which allows the use of an appendage deemed to be of some importance. This is a set of cross-hairs placed at the focus of the eye-glass, to correspond with the twelve positions of the arm of the telegraph, and thus pointing them out without the possibility of mistake. The true numbers, corresponding to the positions as seen in the telescope, may be marked on a diagram placed before the observer; so that, in calling them out, he will not be exposed to any mistake in consequence of the inversion of the image by the telescope, or by the back and front view of the telegraph.

The telescope, being fixed in its position, will be, of course, without the ordinary arrangements for motion. It should be placed entirely within the building; its object end being inserted into a hollow cylinder of wood passing through the wall, and painted black on the inside, so that all stray light may be kept from entering into the telescopes, and distracting the view of the observer.

It is scarcely necessary to add that there must be two telescopes at each station.

4. *Distance of telegraphs.*—The mean distance of the French telegraphs is two leagues, or six miles. In the experiments made by Parrot, and in which the image was very distinct, the distance was ten wersts, or about 7½ miles. The distance must be, in some measure, determined by the suitableness of the stations in other respects; but the maximum should not probably exceed 7½ miles, or the mean, six.

In selecting the stations, care must be taken that there be no considerable deviation from the front view of the telegraph on either side; and that it may be seen, from the adjacent stations, projecting against the sky.

5.—*The time of signals.*—In the French telegraph, the time required for each signal is estimated at 20 seconds; but it is believed that the simple signals of the proposed telegraph can be made and repeated much more rapidly; each signal in the former requiring three movements, in the latter only one. Far greater attention, morever, is necessary in the French telegraph, to see what is the true signal made; and this also requires time.

M. Parrot, from his experiments, estimates that it will require three seconds to see with certainty, and to dictate a signal made; three seconds to repeat it; and three to remain till it be repeated at the next station: in all, nine seconds—say ten—for each signal.

A line of telegraphs from New York to Washington would require about 40 stations; hence a signal made at New York would be repeated at Washington at the end of 400 seconds, or 6⅔ minutes. A despatch of 100 signals would require 1,000 seconds, or 16⅔ minutes at the first telegraph, and would be communicated to the last at the end of 1,400 seconds, or 23⅓ minutes.

6. *Telegraph buildings.*—On the line of telegraphs the buildings may be of wood, about 22 feet square, two stories high, and with a roof in the form of a quadrangular pyramid, surmounted by a small platform. In such a building it is judged that the arrangements for the telegraph, and for the necessary accommodation of the operators, may be made. In the cities, the telegraph must be placed on the top of some suitable building of considerable height.

7. *Men and officers.*—In urgent cases, three persons ought to be employed at each telegraph while it is in operation; one at each telescope, and one to make the signals. The observers may easily record the signals as they see them—if, indeed, this be necessary. In ordinary cases, two operators, or even one, will be sufficient; but as a lookout should be kept constantly, both day and night, less than three persons ought not to be employed at each station.

At each *principal* station there should be a secretary. Every ten stations should have a superintendent; and, if the system be considerably extended, there should be a director-general to take charge of the whole business, with book keepers and clerks to assist him.

8. *Estimate of cost.*—Although the committee cannot pretend to accuracy in their estimates of the cost of establishing and maintaining a line of telegraphs, they have thought that even an imperfect approximation might be deemed of some interest and importance, and they have accordingly prepared the following:

*At each station on the line.*

| | | |
|---|---|---|
| Cost of ground for the building and enclosures | $ 100 | |
| " building | 1,000 | |
| " necessary furniture | 200 | |
| " well and pump | 100 | |
| | | $ 1,400 |
| Cost of telegraph and fixtures | $ 300 | |
| " two telescopes | 100 | |
| " clock | 20 | |
| " transportation and putting up | 80 | |
| | | 500 |
| contingencies | | 100 |
| Total *first cost* | | $ 2,000 |

*Annual expenses of each station on the line.*

| | | |
|---|---|---|
| Salaries of the operators, which may be a man and his family | 1,000 | |
| Fuel | 50 | |
| Oil | 50 | |
| Contingencies and repairs | 200 | |
| | | $ 1,300 |

*Annual expenses for officers, &c.*

| | | |
|---|---|---|
| Salary of Director-General | | 2,500 |
| each Superintendent | 1,000 | |
| Horse and traveling expenses, extra | 300 | |
| | | 1,300 |
| Secretary at principal station | | 1,000 |
| | | $ 4,800 |

*Estimate for a line from New York to Washington.*

| | | |
|---|---|---|
| 36 telegraphs, at $2,000 each | 72,000 | |
| 4 city telegraphs, at $5,000 | 20,000 | |
| | | 92,000 |
| Contingencies, and general superintendence of erections | | 8,000 |
| Total prime cost | | $ 100,000 |
| Annual charge of 40 telegraphs, at $1,300 each | | 52,000 |
| Five superintendents, viz: two between New York and Philadelphia: two between Philadelphia and Baltimore; one between Baltimore and Washington | | 6,500 |
| Four Secretaries at the four cities | | 4,000 |
| Total annual cost | | $ 62,500 |

9. *Selection of lines of Telegraph.*—The lines of most obvious necessity are those from the bays, along the rivers, to the great cities. As a general line, one from New York to Washington would be of great interest and importance. If found successful, lines might be afterwards extended to other great points.

For the location of the stations, it would seem particularly suitable to employ the services of the corps of topographical engineers.

10. *Experimental telegraphs.*—In conclusion, the committee would respectfully suggest to the Secretary of the Treasury to consider the propriety of causing two telegraphs to be erected, in which careful experiments may be made on all the points that bear upon the general question submitted to him by the House of Representatives; and the services of the committee, in erecting the telegraphs and conducting the experiments are hereby offered to him, should he think proper, and feel himself authorized to act upon this suggestion.

By order of the committee,

William Hamilton, *Actuary.*

Philadelphia, April 18th, 1837.

# Mechanics' Register.

LIST OF AMERICAN PATENTS WHICH ISSUED IN JULY, 1837.

*With Remarks and Exemplifications by the Editor.*

148. For a *Rotary Press for pressing Woolen and Cotton Goods;* Moses Bayley, Salisbury, Essex county, Massachusetts, July 5.

A cast iron steam box is to be made, the upper side of which is to be concave from end to end, so as to receive a cylinder, between which and the box the pressing is to be effected. The length of the box must be equal to the width of the cloth to be pressed. The cylinder, adapted to the concave, is made to fit it exactly by a covering of cloth; a roller to receive the cloth as it is pressed, by passing between the cylinder and concave, lies upon, and extends along said cylinder. When hot pressing is to be effected, steam is let into the steam box, the cylinder turned by proper gearing, and the cloth passed through, and rolled up, as indicated.

Claim.—"What I claim as my invention in the within described apparatus for pressing cloth, is the using of a metallic box so formed as that a pressing roller may be made to revolve within a concave extending along it, and into which box, steam or other heated material may be admitted when required; the whole constructed for the pressing of cloth, either hot or cold, substantially in the manner herein set forth."

149. For a machine for *Thinning Cotton in the Rows whilst Growing;* John Weaver, city of Washington, July 5.

This machine is nearly identical with one for the same purpose, patented by Jordan Gatling, on the nineteenthof June, 1835, and noticed at page 50, Vol. XVII. The slight difference consists in a revolving harrow, which it is not necessary to describe particularly, and to which the claim is limited.

150. For a *Pistol Knife, or Cutlas;* George Elgin, New York, July 5.

The blade of the knife, or cutlas, extends back on the lower side of the pistol barrel, to which it is firmly attached, and it extends forward of the barrel, to any required distance, its back still being in a line with the lower side of the barrel, so as to be entirely out of the way when the pistol is fired. The claim is to the combining of the pistol and blade in the manner described.

151. For an improvement on the *Axle and Thorough Box for Carriages* of various descriptions; William Slicer, Baltimore, July 5.

The particular arrangement of the respective parts of the box and axle would require a drawing for their explanation. The claims are to "the extension or projection of the box back of the hub, by which I use an axle with an arm and box of extra length. The outer form of the box, being constructed with a large flanch, or collar, against which the hub is firmly fixed by a nut on the small or outer end of the box, and against the outer end of the hub. The method of fastening the box in the hub by a nut, coupling, or other fastening, on the outer or small end of the box. Using the outer end of the box, by stopping it with a screw or otherwise for the point of bearing, to prevent the wheel from running too far back on the axletree. The use of this or any other form of axletree, without collar, washer, shoulder, or other bearing, except the point of the axle. The use of this conical or pointed axle without a nut or linch-pin, or other fastening on its outer end.

152. For an improvment in the *System of Cutting Garments;* Andrew Wiswell, Exeter, Rockingham county, New Hampshire, July 11.

The illustrations of this system extend through six sheets of drawings, which, as we have not taken the trouble to understand, we cannot explain.

153. For a *Tobacco Press;* James T. Bowman, Pattonsburg, Botetourt county, Virginia, July 5.

The follower of this press is brought down by a screw in the usual manner, and the pressing is effected in a number of cells, or separate compartments, divided from each other by sliding partitions. The pound, or other rolls, to be pressed, are put into the cells, each with a separate block upon which the follower is to act. There is a contrivance for elevating the tobacco in the cells, and the sliding partitions, simultaneously, by means of a lever beneath them. The claim is to the "press for pressing tobacco, made and operating substantially in the manner of that herein described; that is to say, having sliding partitions which can be raised so as to form separate cells for the reception of tobacco, and withdrawn for its removal after it has been pressed."

154. For a machine for *Spreading Lime, Ashes, and other kinds of Manure;* Francis H. Smith, Baltimore, July 5.

The material to be spread is put into a cart, the bottom part of which, about a foot in the rear of the axle, is formed into a hopper, within which two rollers, reaching from side to side, revolve by means of cog-gearing moved by a driving cog wheel upon one of the hubs. The rollers are to be of iron, and one of them is to be fluted, or armed with protuberances projecting out about three-fourths of an inch; the other may be smooth: one of the rollers is borne up by a spring, which is very strong, but will give way should a stone too hard to be crushed pass between the rollers. The claim is to the combination of the two revolving cylinders, with the spring to admit of their receding. The application of the cog gearing as described, and the mode of regulating the velocity by different pairs of wheels fitting on the same centres.

155. For improvements in the *Plough;* Samuel Hartpence and John D. Bowne, Kingwood, Hunterdon county, New Jersey, July 5.

We have repeatedly remarked that after the numerous patents for ploughs, amounting, in this country only, to upwards of two hundred, individual improvement of a striking character ought not to be looked for; but still, those acquainted with the progress of improvement in this instrument are well aware that our ploughs are better in many respects than they were ten years ago.

The claim is all that we shall offer in relationship to the plough mentioned at the head of this article; and, indeed, is as much as is usually necessary. It is to "the manner of constructing the cutter with a screw bolt above, passing through the beam; and a holdfast, or clip, below, passing through the piece forming the share and point, made in the manner set forth, and holding the whole together substantially as described. Also the placing of a roller upon the rounded part above the cutter, for the purpose of preventing the clogging of the plough."

156. For a *Plough;* John C. Smith, Kingwood, Hunterdon county, New Jersey, July 11.

The claim in this plough is to the "making the share of a rhomboidal figure, beveled and brought to a cutting edge on two of its ends, so that when one edge wears away it can be reversed, or turned end for end, being secured to the sheath by two screws near the centre."

157. For a *Machine for Hatcheling Hemp, &c.;* Phineas G. and Gabriel Rice, Danville, Mercer county, Kentucky, July 11.

A large cylinder set with teeth has four, or any other convenient number, of slats, supported above its upper side, and set with teeth pointing towards the cylinder. A doffing cylinder, set with card teeth, removes the tow from the main cylinder, and it is carried off from the doffer between suitable rollers. The hemp to be hatcheled is fed by hand on a board whence it passes between feed rollers, and is hatcheled between the toothed cylinder and slats; the unhatcheled end being held in the hand. When it has been operated upon sufficiently, the motion of the feed rollers is reversed by the aid of a lever which acts upon a band and pullies in a way to produce this effect; the hatcheled part is thus withdrawn, the motion again reversed, and the other end of the hemp passed in.

It will be perceived that this machine offers but little novelty, and the claim is, therefore, very limited, embracing only "the reversing motion given to the feeding rollers, for the purpose set forth, in combination with a machine for hatcheling, the parts of which are constructed, arranged, and combined substantially in the manner described."

158. For a *Combination Spring and Bolt Sash Fastening;* Philip F. Hazard, Philadelphia, July 11.

The sash fastening described in the specification of this patent resembles very closely such as have been heretofore employed, the main novelty consisting in the employment of a spring sash fastening on one side of the frame, and a permanent bolt on the other; the former of which serves to retain the sash at any height to which it may be raised, and the latter to secure it in its place when it is down. Several modifications of the plan proposed are mentioned, which it would not be interesting to detail. The claim is confined to the combination of the spring and permanent bolts.

159. For an *Apparatus for Colouring Maps;* Lucius Stebbins, Hartford, Hartford county, Connecticut, July 11.

The claim is "to the printing the colours upon maps by means of separate stamps, the surfaces of which are covered with some yielding and absorbent material, and which are cut into the form of the various divisions to be coloured, and are supplied with colouring matter, and forced against the map, in the manner set forth."

A table is made, the top of which should be of metal, and as large as the map to be coloured. This is divided by partitions raised from it, into cells, or troughs, corresponding with the outlines of the divisions on the map. Each of these troughs contains the proper colouring matter, and a plate fitting it, and covered with cloth to absorb the colour. These plates can be raised simultaneously by a press acting upon stems descending from their under sides, the map being placed above and sustained by suitable means. The plan is intended in particular for school atlases.

160. For improvements in the *Apparatus, or Machinery, employed in the Manufacture of White Lead, or Carbonate of Lead;* Charles Ripley, Saugerties, Ulster county, New York, July 11.

The patentee states that "the general principle upon which he proceeds to produce white lead, or carbonate of lead, is by exposing blue, or metallic, lead, in suitable apartments, or chambers, to the action of the vapour of vinegar, or acetic acid, to carbonic acid, and to oxygen gas, at such a temperature produced by steam, as shall best promote the chemical reaction of these agents, so as to produce the substance in question."

The claims made refer to the particular arrangement of the gas and steam pipes, and the mode of governing the supply of the requisite agents in the corroding chambers; all which is fully exemplified by references to drawings.

161. For improvements in the *Machine for moulding Candles;* Joseph H. Tuck, Nantucket, Massachusetts, July 11.

"By the use of this machine it is intended to mould a number of candles upon continuous wicks, the moulded candles being drawn from the moulds by suitable apparatus, a fresh supply of wick being at the same time drawn into the moulds, and so on in succession, until seven, eight, or any other convenient number, are moulded upon each wick, which number will be governed by the height of the machine, after which the candles are to be separated from each other." The particular arrangement of the respective parts of this machine is fully explained and represented. The patentee says, "I do not claim to be the inventor of stands of moulds, nor of several other of the individual parts of the machine described; nor do I claim the invention of simultaneously drawing the moulded candles from their moulds by means of a rising frame, this having been previously done, but in a manner differing essentially from that which I have adopted. But what I do claim is the successive moulding of a number of candles upon the same wick without the necessity of separating them from each other until a number have been moulded, in the manner herein described. I also claim the whole arrangement of what I have denominated the sliding shutters, the wick directors, and their appendages, operated upon by sliding frames substantially in the way and for the purpose set forth."

162. For a *Serving and Worming Mallet;* John B, Petival, civil engineer, Charleston, South Carolina, July 11.

There have been two or three patents for apparatus for serving and worming ropes for marine purposes, in which the yarn to be employed is wound upon a reel, or bobbin, separate from the worming mallet. That which forms the subject of the present patent consists of a mallet, the head of which is hollow, and contains the bobbin upon which the yarn is to be wound. A groove is made along the mallet, in the usual way, to receive the rope which is to be served, or wormed.

"What I claim as constituting my invention, is the making the head of a worming, or serving, mallet, hollow, so as to receive and contain the bobbin, or bobbins, upon which the yarns are wound which are to be employed in the process of worming, or serving." It is proposed by the patentee to make the head of the mallet of metal, which will leave more room in the interior, and it may be made lighter than those of wood.

163. For an improvement in the *Mode of Hanging or Suspending a Band Wheel* in those horse powers in which the band is conducted under the feet of the horse; Isaac Straub, Lewistown, Mifflin county, Pennsylvania, July 11.

The claim is to the sustaining the band wheel, which is horizontal, by means of necks and collars, placed above the wheel, without any step, or bearing, below it. The collars are, of course, attached to the frame work of the machine. This manner of fixing such wheels, for aught that appears, is new, but we do not see the particular advantage to be derived from so hanging them and are apprehensive that friction will not be diminished, or permanence promoted, by this device.

164. For improvements in the machine for *making rivets for steam boilers;* and for other purposes; Levi Severance, Pittsburg, Allegheny county, Pennsylvania, July 11.

The arrangement of the gripping, cutting off, and heading, parts of this machine differs from those which have preceded it, and are well contrived. The claims are limited to this particular manner of constructing these parts. We have specimens of rivets, both of iron and of copper made by this machine, and they are perfectly well formed. The most careful among the boiler makers, however, object to the machine-made rivets for iron boilers, on the ground that the iron ought to be of a welding heat for each individual rivet, when made; it being, otherwise, liable to split in riveting, and is brittle when finished.

165. For an improvement in the method, or art, of *Carbonating and Smelting Iron Ore;* Asa Whitney, Smithfield, Orange county, New York, July 17.

"I build within the stack of a blast furnace, a cementing chest, or tube, which I can close at the top, and which has an aperture in the bottom through which the prepared ore descends as it melts, into the crucible of the furnace. I surround the said cementing tube, or chest, by spiral flues through which I cause the heat of the furnace to pass." The particular manner of constructing the cementing tube, the flues, and other appendages, is well represented in the drawings accompanying the patent.

"Having good fires in the tubes for heating the air, and the cementing chest nearly full of charcoal, or coke, which is burning out, or slowly passing down the aperture at the bottom, into the centre, or confluence of the three currents of heated air, in the crucible, I begin to charge the cementing tube with such proportions of ore and fluxes as may be proper for smelting and promoting good separation of the metal from the scoria, with just as much carbon as may be necessary for carbonating the same, and as it settles down I continue to supply more at the top through the feed box, which I close immediately after each charge, until the cementing chest is full, or, to speak more correctly, until the ore and fluxes have descended to the aperture, at which place I expect the ore to be perfectly carbonated, and that it will smelt easily as it passes into the crucible, with good separation of the metal from the scoria; and thus continue working with regular seriatim charges."

"The advantages to be derived from using the before-described furnace are particularly prominent in situations where charcoal is scarce, and other fuel, such as anthracite coal, &c., is abundant; or where ores are abundant and the quantity of charcoal is limited in proportion to the supply of ore."

"What I claim as my invention and discovery, and not before known, is, the building of a cementing oven, or chamber, within the stack of the furnace, and thereby carbonating the ore free from the influence of oxygen, as much as possible; also the form of the crucible, and the application of heat for carbonating and smelting the ore by making the current of air pass in a spiral manner round the cementing chamber up to the smoke chimney."

We have thus given several extracts from the specification of this patent, which are calculated to afford a good general idea of the nature of the thing proposed to be done and of the means by which it was to be accomplished. It will be recollected that the separate carbonating of the ore was proposed in a patent obtained some two years since, by Mr. Boyden, whose plan made much noise for a time, but soon passed from public notice, in consequence of its utter failure. Without pretending to the skill of the practical iron master, we had anticipated such a result from examining Mr. Boyden's specification, as it was apparent, upon the face of it, that the scheme was an untried one, and the means proposed, if carried out, would have been attended with great expense. We believe also, that Mr. Whitney's project has not been carried into operation; he, however, has the reputation of great skill and experience, and we know that it was his determination to test his plan fully; this, we doubt not, would have been done long since but for that state of paralysis which has arrested the voluntary motion, and nearly destroyed the vitality, of all manufacturing and commercial establishments and enterprises.

Without intending to impugn the idea that iron may be carbonated in the smelting furnace, by means analogous to those described, we much doubt the possibility of performing this process upon the unsmelted ore; believing that it is with the reduced iron, and not with the ore, that the carbon combines; and that the ore will be prepared for this combination, in the cementing chamber, only by its being brought to that elevated temperature which will eventually effect its fusion, as it escapes into the crucible. Some may view this question as one of mere theory, but it is important that the true rationale should be understood, as this may lead most directly to a correct practice.

166. For an improvement in the mode of burning fuel in furnaces, by means of a *Suspension Grate;* Thomas Pearson, Monroe Works, Orange county, New York, July 17.

This suspension grate is intended for smelting, and other, furnaces, and is described as being used in Whitney's furnaces, which forms the subject of the last article. The general description of this grate, preceding the references to the drawings, as given in the specification, is as follows:

"I suspend each grate bar by one end, upon a pivot, or general suspension bar, and upon which every bar in the grate is also suspended. The grate bars are inclined, so that the fuel will easily slide, or pass down, them as the fire consumes away, as also will any scoria, or cinder, that may form during the combustion of the fuel. At the bottom of the grate is an inclined stone, dipping towards, and passing under, the bottom ends of the grate bars, down which the slag, or scoria, will flow into the ash-pit. Near the lower ends of the grate bars is a circular bearer which is turned into grooves for the grate bars to rest upon, and by which they are kept at a proper distance from each other. Upon this said circular bearer are as many wrought iron wipers placed firmly as there are spaces between the grate bars, and which arms, or wipers, by turning the bearer round, clear out any slag that may have accumulated at the bottom of the grate bars."

The claim is to the apparatus as above described.

167. For machinery for elevating hay into barns, and upon stacks; George Welbur, Macedon, Wayne county, New York, July 17.

A frame is made which consists of horizontal sills resting upon the ground, supporting two vertical timbers, united by suitable cross-ties. This frame is to support an inclined plane which may be twenty eight feet long and six feet wide, with ledges on each side to keep the hay from falling off. There is a windlass attached to the frame, by means of which the elevation of the plane may be altered at pleasure. The hay is to be deposited upon a receiver, at the bottom of the plane, and drawn up by ropes passing around pullies at its upper end; as it is drawn up it is sustained by a rake below it, to which the above named ropes are attached. The claim is to "the combination of an inclined plane with an elevator upon which it is supported and by which its height is regulated, both possessing the characteristics and construction substantially as above set forth."

168. For an improvement in the *Floating Dry Dock;* James Barron, Philadelphia, July 17.

This floating dry dock is to have its bottom and sides formed of logs from one to two feet square, laid in tiers lengthwise, and then crosswise, bolted together by wood bolts of from three to four inches in diameter, which, it is said, is double the size of those ordinarily used. The sides are to be double, with a considerable space between them, answering the double purpose of strength and buoyancy; this space being secured against the admission of water. There are gates at one end, as usual in such docks, to admit the vessel to be repaired, and there are the requisite appendages of blocks and shores to sustain the vessel when entered.

The mode of pumping out the water, or rather of discharging it, is a prominent feature of this apparatus. Within the dock there are two boxes which, ordinarily, rest with their bottoms upon the bottom of the floating dock, when one side of each rests also against one of the sloping sides of the dock. These boxes admit the water from the dock into them, through suitable valves, and they are capable of being raised and tilted by means of tackle attached to timbers above them. Towards their inner sides, these boxes are placed at some considerable distance apart, and as their sides recede from each other, being parallel to the outer sides, which slope outwards, they may be tilted towards each other, so as to stand nearly on their inner and lower angles, without interfering; these angles have gudgeons which constitute the joints upon which they tilt. Those gudgeons which are towards the fore part of the dock are hollow, and constitute tubes through which the water in the boxes is to be discharged, valves being fixed at their outer ends to prevent its return. In some cases a siphon is also to be used to aid in the discharge of the water.

The patentee states that by the means proposed, a dock for all merchant purposes can be pumped out by two men in one hour. We have made no calculation on this point, but upon the face of the thing, are apprehensive that this estimate is much too liberal; one thing is certain, that neither by this, or by any other method, can two, or any other number of men, raise more than a given weight of water to a given height in any designated period of time.

The claims are to "the construction and arrangement of the different parts of this dock; in the building it of logs; the method of pumping it out as above described, and also the economical means of connecting the whole mass together by wood bolts double the size of those which can be used in vessels of the ordinary construction." The latter part of this claim we view as altogether untenable, there not being any thing new in the use of pins, or treenails for holding logs together; and as to their size, if there be a dividing line below and above which they are and are not patentable, we should be glad to have it marked out.

A modification of the tilting box is proposed and claimed. This modification will be understood by supposing the two boxes to be united together by their inner sides, so as to constitute a single box divided into two compartments by a partition, with their lower sides uniting in an obtuse angle, which forms the bearing upon which the box may be made to rock from side to side.

169. For improvements in the *Plough;* J. B. Norton, Philadelphia, July 17.

The claims made are to "the graduation," which is to a mode of fixing the clevis in any desired position, so as to cant the plough, and increase the width of the furrow, also to "the manner of strengthening and screwing the share to the mouldboard," which though believed to be new so far as the particular means adopted are concerned, does not offer any thing worthy of special notice: a projection formed on the landside for the handle to rest against, and the method of securing the mouldboard to the beam by means of a staple, are likewise claimed.

170. For a machine for *Reducing Thread Waste to the state of Cotton Wool;* Ogden Griswold, Hartford, Hartford county, Connecticut, July 17.

The claim is to "the construction and arrangement of the machine described, in which the waste threads are caught upon hooks, pins, or teeth, on a revolving reel or cylinder, and are whirled round and beaten against the edges of knives, or metal plates, so as to untwist them, and separate their fibres, in the manner set forth."

"The thread waste is placed upon a feeding apron, and is conducted by feeding rollers to a revolving reel, or cylinder, set with hooked teeth, along its projecting bars, or periphery, by which teeth the threads are caught and whirled round with great rapidity. The reel or cylinder is surrounded for more than half its circuit by plates of iron, which I denominate knives, against the edges of which the threads are beaten, causing them to separate into fibres. These knives extend from side to side of the frame of the machine, they are, lengthwise, parallel to the axis of the reel, or cylinder, and widthwise, form an angle of about forty degrees with its radii."

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171. For an improvement in the *Horse Power;* Levi Rice and Daniel Cogden, West Chester, Chester county, Pennsylvania, July 17.

This horse power is intended for two, or more, horses, to walk in different directions upon a horizontal floor. This floor is to be made of separate pieces of plank of sufficient length for the animal to walk upon. Suppose three horses to be employed, the floor is in this case to be so placed as to form a triangle, each side of which is long enough for a horse path; at each angle there must be a vertical shaft around which the floor is to revolve; a driving pulley is fixed upon each of these shafts, and is scolloped so as to fit into the inner, and curved ends of the planks which constitute the floor. The planks are connected together by joint straps on their flat sides, allowing them to open and close like the joint of a two foot rule, or rather like that of a card table hinge. The floor must be supported upon rollers. It will be seen by the foregoing description that there is much complexity in the affair; a complexity which, we apprehend, will soon condemn it to desuetude. The claim is to "the forming a horizontally revolving floor, with three or more centres, making it in the form of an oblong, triangular, or square figure, for two, three or more horses; and the right of shaping the ends and sides of the planks in any form so that the plurality of centres is preserved in the floor, for the purpose of propelling rail-road cars, thrashing machines, &c."

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171. For an improvement in the *Horse Power;* Levi Rice, Attleborough, Bucks county, Pennsylvania, July 17.

The claim is this horse power is simply to the manner of using plates and staples to connect the plank of which the endless floor is constituted, and to a variation in the manner of arranging the band of rollers upon which it is sustained; the whole affair is of no great importance, although possessed of some little novelty.

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173. For an improvement in the method of *Making Soap;* Daniel E. Stillwell, Utica, Oneida county, New York, July 17.

Hard is to be converted into soft soap, by dissolving about eight pounds of common hard soap in four quarts of soft water, heated over a fire, and then adding four ounces of sub-carbonate of soda; the mixture is then suffered to cool, and is ready to use as a convenient and active detergent. The patentee claims the foregoing combination as producing a material suited to become an article of commerce.

174. For an improvement in the *Construction of Carriages*; Samuel C. Brown and Levi J. Hicks, Macedon, Wayne county, New York, July 17.

This patent is taken for an improvement in the construction of what is sometimes called the fifth wheel of a carriage, which consists of the apparatus upon which the axle of the fore wheels is sustained, and revolves horizontally, when the carriage is being turned. The claim is to "the use and application of cast iron in the construction of the fifth wheel; in combination with the convexity of the lower wheel; the flanch attached to said lower wheel; the flanch on the upper wheel, and the socket that receives the reach, or perch." These claims it will be seen, refer to certain peculiarities of construction which appear to possess sufficient novelty to justify the grant of a patent.

175. For an improvement in the construction of the *Valves for Pumps;* Henry Heckman, Newburg, Cumberland county, Pennsylvania, July 17.

The whole claim to invention in this patent, consists in the forming of the valves for pumps of flat plates, covering the orifice in the seat, and keeping them in their places by two staples, crossing each other at right angles.

176. For an improvement in the *Machine for pointing and cutting Wooden Pegs*, for pegging boots and shoes; Joseph Essex, Killingly, Windham county, Connecticut, July 17.

"By means of this machinery, the blocks, after they have been sawed and dressed to the proper thickness for the length of a peg, are first scored in two directions, so that the pegs when cut shall be sharp pointed, and afterwards split in two directions to complete them. The pointing is effected by means of revolving cutters which are fixed upon strips sustained like the rounds of a reel, by means of arms projecting from a revolving shaft." The particular apparatus for moving the block in the operation of pointing, and subsequently in that of splitting, cannot be described without allowing more space to it than the subject will warrant.

The patentee says he does "not claim the scoring, or the pointing of pegs by means of revolving cutters, but the manner of constructing and arranging the revolving cutting apparatus, having the cutters upon adjustable strips, in the manner set forth; also the double platform, the upper portion revolving on the lower, in the manner described."

177. For an improvement in *Rotary Stoves*, by adding an oven thereto; Rensellaer D. Granger, Troy, New York, July 17.

The rotary stove upon which the proposed improvement is made, is that usually known as Stanley's. From the centre of the revolving top, a pipe, furnished with a valve, rises vertically; a second pipe, also, rises vertically from the back part of the stove, clear of the rotary top, and leads, as does the first pipe, into the double case of an oven elevated above the ordinary height of the boilers which occupy the openings in the rotary top. By this arrangement a current of heated air may be directed between the double casing of the oven, whilst the other parts of the stove are continued in use. At the ends of this elevated oven, which may be round or square, there are doors, and within it suitable shelves to receive the articles to be baked.

The claims are to "the conveying the heated air from the fuel through two or more pipes into an oven elevated above the main body of a rotary stove, allowing the boilers to pass under it; and operating substantially upon the principle set forth." There is also proposed to be a swell, or curve, formed on the rotary top, to admit of a larger boiler than usual, when desired, the making of which is likewise claimed."

178. For an improved *System of Tailoring;* Amos Sherman, Newark, Essex county, New Jersey, July 17.

The philosophy of the system of tailoring belongs to a class of Savans into whose school we have never been admitted; but we apprehend from the various reports of "Mathematical," "Standard," "Geometrical," and numerous other instruments for ascertaining the human contour and dimensions, that this department of science must be brought as nearly to perfection as are our terrestrial admeasurements by triangulation, or our knowledge of the longitude by the aid of chronometers, lunar observations, and the eclipses of the satellites of Jupiter. If we are mistaken in this conjecture, it belongs not to common minds to detect the error; and should a garment be now and then spoilt, this will no more prove that the philosophy of tailoring is not perfectly understood, than the use of a wrong exponent by the mathematician would prove that his science was incorrect.

In those departments of knowledge which are the most advanced, great discoveries are scarcely to be hoped for, but still every thing is progressive, and we should set a due value upon every step made towards absolute perfection, however short it may be, or however modest the terms in which it may be announced. After these preliminary remarks, we offer the following summary of the improvements now presented to us, which is in the following words: "The invention claimed by me, the said Amos Sherman, and which I desire to secure by Letters Patent, consists in the before-described method of taking measure, and cutting clothes; also the addition of the projection, or blade, to the square, and attaching the tape to the hook E, of the blades, as described."

179. For an improvement in *White Paint;* Forrest Shepherd, New Haven, Connecticut. First issued March 18th, 1835; surrendered and reissued, July 17. (See Specification.)

180. For an improved *Water Colour Paint*; Forrest Shepherd, New Haven, Connecticut, July 17th. (See Specification.)

181. For an improvement in the mode of *Applying Horse, or other Animal Power, to Propelling Machinery;* Barnabas Langdon, Troy, New York, July 19.

We have not here a perpetual motion, or any thing which actually sins against the laws of mechanics; still we are very apprehensive, that the patentee, who manifestly believes that he has devised an advantageous mode of communicating the motive power of animals to machinery, will eventually discover that he has been treading in a circuitous path, whilst he might, at less expense of time and labour, have gone directly up to his object by one of the more common and direct roads.

The horse, or horses, employed are to walk in a circle, and to draw by levers attached to a vertical shaft, in the manner well known. The machine as represented is for four horses, there being four arms or levers extending from the vertical shaft. Within the horse track there is to be a circular rail way, and upon this rest four wheels, each having for its axis one of the horizontal shafts above named. A circular platform, which may be equal in diameter to the circular railway, rests upon the tops of these wheels, and in order to produce the necessary adhesion, weights to any desired amount may be placed upon it. From this platform, motion may be communicated to machinery by affixing a cog-wheel on its upper side, with a pinion on a horizontal shaft working into it by bevil gear. This is the sum and substance of the machine, the description of which closes with the subjoined formidable claim.

"What I claim of the improvement thus above described, is the manner in which the circular flat rim, or platform, is made to revolve horizontally in its own circle by means of the progressive motion of three or more rollers, or wheels, rolling round a common centre upon a circular track, or railway, under the propulsion of horse, or other animal power, with the rim or platform placed on the top of the rollers and being supported and carried round by them; and the manner of accelerating its motion by means of longer wheels to be fixed by the side of such railway rollers upon the same shaft; and also the manner of communicating the power and effect of the momentum of the rim or platform, thus acquired, to other wheels, by the intervention of cogs, bands, or other means in common use, for the purpose of obtaining rotary movements for mechanical, manufacturing, or other practical purposes,as above described, together with the provision for adding weights as an overload for increasing the momentum, or friction, of, or between, any of the revolving bodies in connexion, as may be required; and also the principles embraced by the said improvements so far as the same are applicable to machines of the above description."

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182. For a sounding instrument for *Ascertaining the depth of Water in Seas, Rivers, &c.;* Francis B. Ogden, of New Jersey, and John Ericsson, of Sweeden, July 19.

This instrument is intended to ascertain with accuracy the depth of water, or soundings, from a ship or vessel, when, by reason of currents, the rapidity of the vessel's way through the water,or other causes,it cannot be determined in the usual manner by the lead-line." "The invention consists in ascertaining the depth by means of the pressure of the water, which at given depths is always nearly alike, the water being allowed to enter the instrument and made to compress a certain quantity of atmospheric air contained therein, and to overflow the orifice of a small tube, into a glass tube, or recipient, in which it will rise in proportion to the superincumbent pressure, and thereby indicate the depth to which the instrument may be lowered." The claim made is to an instrument so constructed as to operate in the manner above indicated. The particular construction of such an instrument may admit of some variation, but the general principle upon which it operates will, we think, be sufficiently apparent.

183. For an improved construction of *Grates and Fire Places;* Ellison Conger, Newark, New Jersey, July 22.

"The nature of my invention consists in supporting the coal upon a hearth, and making the flue at, or near, the bottom; thereby obtaining a horizontal draught of air through the fire, either direct or laterally." One of the figures in the drawing represents an open, or Franklin stove, with its hearth as usual, but having an opening for the flue just above the level of the back of the hearth; this flue leads into what is denominated a heat chamber, behind the fire, which, though it differs from heat chambers previously constructed sufficiently to give it some claim to novelty, it is not thought necessary to describe particularly. The other figures show the manner of conducting the horizontal draught through fires in grates in ordinary fire places. The claims made are to the particular manner of arranging the hearth and flue to obtain the horizontal draught; to the manner of making a sifter, and to the heat chamber as described.

184. For an improved *Cooking Stove;* Abraham T. Mixsell, Belvidere, New Jersey, July 19.

The claim made is to "the construction and arrangement of the flues as described; and the apertures to admit or exclude the air at the sides of the stove, so that the fuel may be consumed under the hindermost boilers only, when this may be desired." To describe the peculiar arrangement of the flues and valves in stoves in all their varying combinations, would be no easy task, and there are few to whom it would be acceptable, if performed; in many cases the novelty would be small, and the utility questionable, and to be determined by the test of experiment only; and that frequently in one way by the purchaser, and in another by the inventor. There is more *novelty* in the form and arrangement of the valves and flues of the stove before us, than is usually found in these parts, but the reality of the *improvement* is not equally manifest.

185. For an improved *Stove for Cooking and Heating;* William B. Kimball, Peterborough, New Hampshire, July 19.

In this stove there is a hearth at the lower part, with an opening, similar to that of the Franklin stove, in which wood may be burnt in the usual way; and above this there is an enclosed fire place, in which coal, or other fuel, may be employed, the grate bars standing immediately over the open fire place. There are flues and valves so arranged as to govern and direct the heat under cooking utensils, and around an oven situated at the back of the stove, which appear well calculated to answer the purpose intended. The claims made are to "the particular manner in which the double stoves are conbined with the flues or passages, valves, dampers, or shutters, with each other, as described; not claiming either or any of these parts taken individually, or in the connexion of one individual part with another, but claiming that arrangement of the respective parts with each other, as a whole, so as to constitute a stove substantially the same with that set forth."

186. For improved *Self Adjusting Temples for Looms;* Samuel P. Mason, Newport, Rhode Island, July 22.

These temples are in their general construction very similar to others previously in use, the difference being in the arrangement of the parts by which the jaws are opened. The claim is to "the manner in which the stationary inclined plane and forceps are placed on the plate of iron; the manner in which the forceps are opened by being forced on said stationary inclined plane when assisted by the lathe, and are thrown off the inclined plane when the lathe recedes."

187. For an improvement in the manufacture of *Stoves for burning Anthracite;* Jordan L. Mott, city of New York, July 22.

This is intended to be an economical stove for the burning of, and cooking by means of, anthracite. It differs but little in form from such as have been before made from plates cast separately and put together in the usual manner. It is, in fact, a small open stove with a feeder for the supply of coal, and an opening for a kettle or other cooking utensil, and is intended for summer use. The claim is to "the casting the whole body of such a stove and its feeder, with the exception of the top and bottom, or in some cases conjoined with the bottom, in one entire piece."

188. For improvements in the mode of *Constructing Railroads;* Isaac Cooper, Johnstown, Cambria county, Pennsylvania, July 22. (See specification.)

189. For improvements in the mode of constructing and connecting together, the *Cars and Carriages used on Rail, and other Roads;* Robert Grant, Philadelphia, July 22.

"My first improvement consists in a mode of constructing the wheels and axles of cars or carriages, and their appendages, by which the draught is applied to a wheel which rolls within a rim upon a larger wheel near to its periphery, the tread of which larger wheel bears upon the rail or road. I am aware that this principle has been already applied, or has been proposed to be applied, to the wheels of cars and carriages, but by an arrangement differing essentially from that which I have adopted."

This plan of making a smaller wheel within the periphery of a larger drum, or wheel, has been made the subject of a patent in England, and was spoken of as a plan for enabling a car, or carriage, to carry its own railroad. The whole plan appears specious, but, hitherto, it has proved fallacious; and although the present patentee has manifested considerable ingenuity in the particular arrangements made by him, the structure is thereby somewhat more complicated, without the introduction of any thing apparently calculated to remove the objections to the general plan; we believe, indeed, that these objections are radical.

The second improvement proposed, is in the mode of constructing or coupling trains of cars together by means of a double hinge joint. The claims are to "the manner of connecting the larger wheels by means of revolving tubes which constitute their axes, and allow the axle of the interior wheels to pass through and revolve within them in the manner described. Also the enclosing of the interior wheels by means of a face plate, and the combining therewith a central circular plate admitting the axles of the interior wheels to pass through them as set forth. Also the manner of combining the solid and tubular axles, either of the interior wheels, or of the ordinary wheels of railroad cars. Also the double, or greater number, of vertical hinge joints for connecting trains of cars together. Also the so placing of the middle rail of the frame of a car as that it shall aid in supporting it in case of the breaking of an axle, substantially as set forth."

190. For improvements in the construction of a *Self Sharpening Plough;* Isaac Snider, Mount Pleasant, Westmoreland county, Pennsylvania, July 29.

The claims in this plough are to some small differences from the usual manner of attaching the parts of the plough together, not appearing to require any particular notice.

191. For improvements in the *Machine for Planing Mouldings on Wood*; Ambrose Church, Jr., Canandaigua, New York, July 29.

This machine is for sticking mouldings by means of a moulding plane made to traverse back and forth, by a crank motion, in a manner frequently adopted. The claims are to certain particular devices and modes of arrangement, intended to produce accuracy in the result, and to facilitate the operation, in a way which cannot be shown without the drawings.

192. For improvements in *Fire Arms;* Henry Harrington, Southbridge, Worcester county, Massachusetts, July 29.

The barrel of this gun is to consist of a great number of small tubes, which may be of a proper size for shot; it may be made by soldering these tubes within an ordinary barrel, extending its whole length. At the breech end of the barrel there is to be a mortice to receive a box or chamber, which is to be charged with the shot and powder. The end of this chamber which bears against the barrel is to be covered with a plate perforated with holes which coincide with those in the barrel; these holes are to be somewhat conical, the larger ends being towards the barrel. Shot are to be inserted in each of these holes, and pressed in by the finger; the chamber behind them is then to be filled with powder, and the box inserted in its place, when it may be discharged by means of a percussion cap. The same arrangement is proposed for cannon, and for pistols. The claim is to "the throwing of shot or balls from any number of barrels united together, by exploding powder in a single chamber, substantially in the manner above described." The patentee sets forth the advantages which he anticipates from a gun made in this way; we think, however, that were the disadvantages also to be enumerated, the positive terms would disappear, and there would remain a minus quantity.

193. For a *Process for purifying Salt Water preparatory to manufacturing Salt;* Nils Sholtewskii Van Schoultz, Saline, New York, July 29. (See specification.)

194. For improvements in the machine for *Spinning Woolen Roving;* Edgar M. Titcomb, Andrews, Essex county, Massachusetts, July 29.

"The nature of this invention consists in passing the woolen roving between the opposite sides of an endless belt, while the sides of the belt are pressed into contact with the thread of the roving. While the thread passes between the opposite sides of the endless belt at right angles to those sides, the belt is in rapid motion over and under two rollers, and those opposite sides of the belt moving necessarily in opposite directions, and being in contact with the thread, twist the roving, and prevent its being broken as it is drawn out to greater length and fineness." The claim is to "the application of the endless belt, so as to twist the thread of the woolen roving on its passage from the back to the front rollers."

195. For an improvement in the *Machinery for making Horse Shoes;* B. Young and S. Tistus, Brooklyn, Windham county, Connecticut, July 29.

"What we claim, therefore, is the manner of forming the shoe by the combined operation of the rollers, the guides, the conductor, and the die, arranged and constructed substantially in the manner herein set forth." The shoes, it will be seen, are to be formed, in part, by rollers, but the doing this is disclaimed as not being in itself new; the accessory parts, as represented in the drawings, manifest considerable skill, but whether they remove the difficulties heretofore experienced in making horse shoes by rollers, is a practical question, to be answered only by the machine itself, and we are not informed respecting what character it has established and sustained.

## SPECIFICATIONS OF AMERICAN PATENTS.

*Specification of a patent for an improvement in White Paint, for which letters patent were granted to* FORREST SHEPHERD, *on the* 18*th day of March*, 1835. *Which letters patent were canceled, and reissued upon the following amended Specification*, *July* 17, 1837.

To all whom it may concern: Be it known, that I, Forrest Shepherd, formerly of Fredericksburg, in the county of Spottsylvania, and state of Virginia, but now of New Haven, in the county of New Haven, and State of Connecticut, have invented a new and useful preparation of white paint, to be used in combination with oil, in the same way in which white lead is now used; and I do hereby declare that the following is a full and exact description thereof.

I take the mineral known by the name of sulphate of barytes, barytes, or terra ponderosa, and reduce it to a fine powder, after which, I mix it intimately with oil, and, if necessary, again grind it, in the same way in which paint is usually ground.

With this paint as a basis, any of the pigments now used with other kinds of white paint, may be incorporated, and any desired tint, or shade of colour be thereby produced.

What I claim as my invention, or discovery, and wish to secure by letters patent, is the employment of the mineral, or native, sulphate of barytes, properly incorporated with oil, as a white paint, or as a basis with which various pigments may be used in the process of painting.

FORREST SHEPHERD.

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### *Specification of a patent for an improved Water Colour Paint; Granted to* FORREST SHEPHERD, *New Haven*, *Connecticut*, *July* 17, 1837.

To all whom it may concern: Be it known, that I, Forrest Shepherd, of New Haven, in the county of New Haven, and State of Connecticut, have invented, or discovered, a new manufacture of white water colour paint, using as the basis thereof the mineral known under the name of sulphate of barytes, by means of which a beautiful and perfectly opaque white is obtained; and I do hereby declare, that the following is a full and exact description thereof.

Instead of using oil with the barytes, as described by me in the specification attached to letters patent of the United States, dated the eighteenth day of March, in the year 1835, for "a composition to be used as a white paint;" I take the same mineral, sulphate of barytes, in its native state, and reduce it to an impalpable powder, and I then mix it with water in which there is a sufficient quantity of gum tracacanth, gum Arabic, or other adhesive gum miscible with water, or any other fluid not oleaginous, and adapted to give adhesiveness, or a binding quality, to the pulverized mineral. The composition may, if necessary, be again ground after mixture. This I lay on as water paint, and when properly prepared, it is of a clear white colour, and perfectly opaque. The paint thus prepared, adheres very firmly to wood, &c., and for various purposes will be found extremely useful, especially when it is not exposed to the vicissitudes of the weather; and in situations where it is so exposed, it may be rendered permanent by a coating of good clear oil, or spirit varnish. Various tints and shades of colour may also be given to it by a proper admixture of any suitable pigment, as in the case of the oil paint. This water paint may also be very advantageously applied as a ground coat upon work which is afterwards to be covered by the oil paint.

I am aware that the artificial, or factitious, sulphate of barytes has been used as a water colour by miniature painters, and in other delicate works; but the application of the mineral, or natural, sulphate, as a water colour, is, as I believe, new, and of my invention, or discovery. What I now claim, therefore, and desire to secure by letters patent, is the employment of the natural, or mineral, sulphate of barytes, as a water colour, or paint, whatever aqueous fluid may be preferred as its vehicle, and whatever gummy or tenacious material, or pigment, may be mixed therewith.

FORREST SHEPHERD.

### *Specification of a patent for improvements in the mode of constructing railroads; granted to Isaac Cooper, Johnstown, Cambria county, Pennsylvania, July 22nd,* 1837.

To all whom it it may concern, be it known, that I, Isaac Cooper, of Johnstown, in the county of Cambria, and State of Pennsylvania, have made certain new and useful improvements in the manner of constructing railroads, and I do hereby declare that the following is a full and exact description thereof.

My improvement consists, in part, in the form which I give to the upper sides of the string pieces upon which the rails, chairs, or plates, are to be sustained, or to the upper sides of the block of wood, or of stone, used for the same purpose; in the form and construction of the chairs adapted thereto, and in the manner of combining and connecting the respective parts together, so as to form a more stable foundation and superstructure than have hitherto been obtained at the same cost.

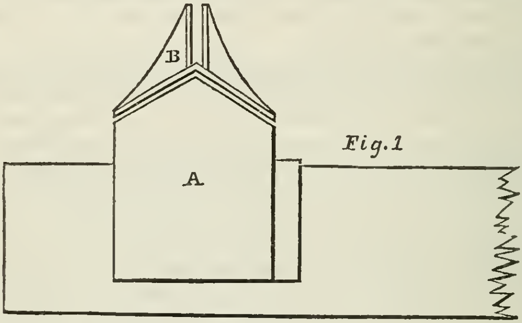
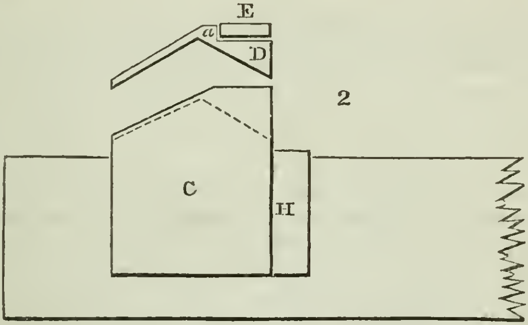


*Fig.1*

I sometimes make my rails by taking string pieces of a peculiar form on their upper sides, and upon these I put edge rails, by means of chairs adapted to the form of such string pieces. Fig. 1, in the accompanying drawing, shows a cross section A, of one of the string pieces of timber, and a side view, B, of a chair adapted thereto. These string pieces may be of any convenient length and size, but it will be found best to make them larger than those ordinarily used? Twelve inches in height and two in thickness, I should prefer. It will be seen by the section that the string piece is made ridge-shaped on the top; the angle formed by the sloping sides may vary considerably, but a descent of two inches and a half on each side will answer all the purposes intended. Instead of descending from the ridge, or middle part, in a straight line, it may do so in one which is somewhat concave, or convex; the chair, in this case, being adapted thereto. The same remark will apply to the blocks of wood, or stone, hereafter to be described. The chair B, is so formed on its under side as to adapt it to the ridge-formed string piece across which it is made to straddle. Such chair, so formed, and firmly attached to string pieces, will afford greater stability, being less liable to displacement, and resisting the lateral thrust more effectually than any mode of forming and fixing such articles, now in use.

When it is desired to use a plate rail, the top of the string-piece must be adapted thereto. In fig 2, is shown a section of such a rail and plate, together with the kind of chair which I have invented, and adapted to be used with rails of that description. The upper sides of the string pieces are, in this kind of rail, sloped towards the outer edge only, commencing from a point immediately under the outer edge of the iron rail plate; C, in this fig. is the section of the string piece, D, the chair, and E, the rail plate. The chair is made in the form shewn in the drawing. The chair is to be let into the string piece, so that its top shall be flush with the top thereof. There is a shoulder, offset, or jog, at *a*, to steady the rail plate; this shoulder may be extended up within an eighth of an inch of the surface of the plate. These chairs I make of cast-iron of such strength as is necessary to sustain the load; they, however, will be found but little liable to fracture when properly imbedded in the rail. The distance of these chairs from each other may vary from eighteen inches to three feet.



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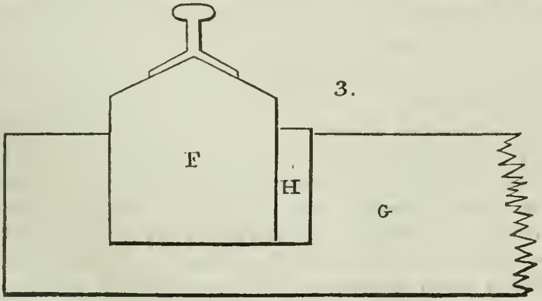
The dotted line shows the depth to which the chair may be let in to the string-piece.

Fig. 3, represents a cross section of a rail-road, and exhibits an improved mode of construction, in which the rail, or the chair which supports it, is placed upon blocks of wood, or of stone, having the upper surfaces of such blocks ridge-formed, in the same way with the string pieces first described. F, are blocks of stone, or of wood, the upper sides of which are ridged-shaped, and their lower let into the cross tie-piece, G, and secured there by means of wedges, H. The tie pieces may vary in size, but abundant strength is a point of much importance: I contemplate having them, usually, about eight feet long, fourteen inches broad, and eight inches thick, and then make the notches to re-



3.

ceive the blocks four inches deep. The rail may be made so as to be used without chairs, in which case its form will be somewhat like that of the T rail, the lower side, however, being rolled in such a shape as to adapt it to the ridge of the block, upon which shape its stability will greatly depend. Edge rails of any of the ordinary forms may be used by employing chairs adapted to them, and to the ridge-formed block. In a road so constructed a stone block foundation will possess the requisite elasticity, from its resting upon the wooden tie piece. If preferred, a similar advantage may be obtained by imbedding the stone blocks on a rubble foundation in the usual way, leaving their upper surfaces flat, and securing the tie pieces above instead of below them. The ends of the tie pieces are, in this case, to be notched, or cut, into such a form as to adapt them to the kind of chair, or rail, above described, that is to say, they must, when these are seated upon them, be ridge-formed.

What I claim as constituting my improvements in the mode of constructing rail-roads, is the giving to the upper sides of the string pieces, blocks, or cross-ties, the ridged form, as herein set forth, for the purpose of receiving chairs, or rails, adapted thereto on their under sides. I also claim the forming of the string pieces with a slope or chamfer, along one side of their upper surfaces, when plate rails are used, and the construction and application of chairs, such as are herein described, to the fixing and sustaining of the rail plates, by which means the plate is enabled to resist the lateral pressure to which it is subjected; and the great strain upon the spikes, and the indentation of the timber, are obviated. I likewise claim the application of cross ties of wood, either below, or above the blocks of stone, or of wood, which make a part of the foundation of a rail-road, in the manner, and for the purpose, fully made known in the foregoing specification.

ISAAC COOPER.

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## *Specification of a Patent for a process for purifying Salt-water, preparatory to manufacturing Salt; granted to* NILS SHOLTEWSKII VAN SCHOULTZ, *Salina, Onondaga county, New York, July 23rd,* 1837.

To all whom it may concern be it known, that I, Nils Sholtewskii Van Schoultz, of Salina, in the county of Onondaga, and State of New York, have invented a new and useful mode of purifying salt water, used for the manufacturing of fine and coarse *salt*, and I do hereby declare that the following is a full and exact description thereof.

The nature of my invention and discovery consists in decomposing the impurities kept in solution by the salt water, which impurities chiefly consist of muriate of magnesia, sulphate of magnesia, muriate of lime, sulphate of lime, sulphate of soda, carbonate of iron, iodine and a bituminous oil, &c. &c.; this decomposition is performed, before the salt water is drawn into the kettles, or pans, in the ordinary wooden cisterns belonging to the salt works, if said cisterns are of such dimensions that they contain sufficient water for twenty four hours consumption in the respective works. But as the impurities must have time to sink to the bottoms of the cisterns, before passing into the kettles, or pans, three cisterns, at least, must be attached to each saltwork, each cistern containing water enough for twenty four hours' boiling, thus permitting the water to settle during forty eight hours.

To enable others skilled in the art to use my invention, or discovery, I will proceed to describe the operation; first remarking, however, that salt waters contained in different wells, differ from each other in their composition, wherefore a different method for purifying the salt water in one class of wells must be used, when compared with the method of purifying the water drawn from the second class of wells.

Salt wells may be divided into two classes. In *the first class*, the impurities consisting of sulphate of lime and carbonate of lime predominate; and the salt manufactured out of that water will be highly impure, by containing the two above named impurities; more or less, in proportion to what the water held in solution before the evaporation. In the *second class*, the impurities consisting of muriate of magnesia and muriate of lime predominate, and the salt manufactured out of that water will not only be impure by containing these two substances, but will never dry in consequence of the two deliquescent salts which continually absorb water from the atmosphere, whereby a continual draining is occasioned, with a consequent loss of salt.

The salt wells at Onondaga, in the State of New York, belong to the first class; the salt wells at Kanhawa, in the State of Virginia, belong to the second class.

For purifying the salt well-water of the *first class*, or where sulphate and carbonate of lime predominate, I take the following method.

For a wooden cistern containing six hundred cubic feet of water, I throw in fifty bushels of charcoal (or mineral coal, if attention is paid to the quantity of carbon contained in the said mineral coal;) then I fill the cistern with the salt-water; when full, *one pound and two ounces* of alum is thrown in and the water is well stirred; then left to settle during forty-eight hours, after which time it is fit for use.

For purifying the salt well-water of the *second class*, or where muriate of magnesia and muriate of lime predominate, I take the following method.

For a wooden cistern containing five thousand cubic feet of water, I throw in one hundred bushels of mineral coal; then I begin to fill the cistern; when half full, I throw into the water one sixteenth part of a bushel of *quick lime* and stir the water; when the cistern is full, *three* pounds of alum are thrown in, the water stirred and left to settle during forty eight hours, after which time it is fit for use. The lime is here used for the decomposition of the muriate of magnesia, precipitating the magnesia and forming with the muriatic acid muriate of lime, which latter is decomposed by the influence of the coal and alum. The lime must first be thrown in and then the alum, because if the order is reversed the lime would act on the alum and decompose it.

To use lime for the purifying of salt well-water, belonging to the first class, for instance at Onondaga in the State of New York, would not only be useless, but hurtful; inasmuch as the lime, decomposing none of the impurities, would be found in the salt.

The above mentioned quantity of coal will be sufficient for a month, but the other substances, alum and lime, must be used every time a cistern is filled.

When the presence of *Iodine* is so great that it corrodes the vessels, I use one fourth part of an ounce of *sulphate of manganese*, which, enveloped in paper, is thrown into the cistern, and is to be renewed every fourteenth day.

What I claim as my mode and discovery, and desire to secure by Letters Patent, is the united effect of *carbon*, *alum*, and *lime*, and *sulphate of Manganese* in the salt well-water, for the purpose of purifying said waters, for the use of manufacturing salt.

N. SHOLTEWSKII VON SCHOULTZ.

## Progress of Physical Science.

### *On the formation of Hail.* By M. DE LA RIVE.

(CONTINUED FROM PAGE 209.)

After having remarked the direction of the storm, and rested for a moment from my fatigue and alarm, I reached the Puy-du-Dôme, a magnificent observatory, where I was still near the clouds. It was now two o'clock, and the state of the skies made me fear other heavy showers, which I was solicitous of avoiding. I then directed my steps towards the Puy-des-Goules, between two and three miles from the top of Puy-du-Dôme, and I ascended it about three o'clock. The heavens were very much in the same state, the two strata of clouds were still apparent, and the south wind, which was very cold, scudded with great strength along the sides of the mountain. It brought along with it another hail-cloud, which appeared to be heavily charged, and in which I was enveloped for about five minutes. The hailstones were numerous, and the largest was scarcely the size of a filbert. They were formed of concentric layers, more or less transparent, and were roundish or slightly oval; they were all carried along in a horizontal direction with great velocity, from which the attraction of the mountain seemed to make them swerve, and many fell upon its sides. Very many struck me without doing me any injury, and they fell as soon as they touched me. The greater part of the cloud passed over my head, and I distinctly heard the hissing noise of the hailstones, or rather a confused noise, the result of an infinite number of partial sounds, which I could attribute to nothing else than the friction of each hailstone against the air. The cloud which passed over my head, and in which all the hail was formed, allowed none to escape beyond half a league from the spot on which I was standing. Some, however, fell on the northern side of the mountain which intercepted its progress, and I collected a certain number of the hailstones in a phial. I subsequently submitted the water to many chemical tests, and I obtained a sensible precipitate, with nitrate of silver and muriate of barytes.

All the hailstones appeared to be subjected to a very rapid rotary motion, but in different directions, so far as I could judge by examining their movements at the moment of their fall on the crown of my hat, which I held as much horizontal as possible to receive them. Many other clouds, charged with hail, still rose from the south, and now on one point, and now on another, it hailed without interruption from one till four o'clock on the chain of the Puys, from Mont Dore, as far as Riom and Volvic.

Between four and five o'clock the hail ceased; the clouds now formed only a single stratum, but they often presented that phenomenon I had noticed in the morning, viz: that they grouped together, and then poured out, along with flashes of lightning, enormous quantities of water. The south wind also had now ceased, the west alone blew, and carried along with it these frightful waterfalls. One of them discharged itself in my view at Barraque, on the great road to Clermont. I was distant from it about forty yards, and not a drop of water fell on me. A heavily loaded carriage which was at a little distance, disappeared in the twinkling of an eye, under the mass of water which the heavens poured down upon it. After the passage of the water-spout, it was overturned in a ditch, and the postilions, for a time, did not try to right it, so intense was the darkness in the midst of the storm. Large pieces of pavement and great blocks of granite were carried along by this waterspout, which still hurried away before me, and reached Clermont half an hour before I could arrive. The storm on the second of August was not so rapid in its progress as that of the 28th of July, and it traversed a much shorter line. It began upon the mountains of Cantal, and terminated upon the confines of Auvergne and Bourbonnais. M. L. de Bunch, who, that day, was at Cantal, ineffectually attempted, at ten in the morning, to reach the summit of Puy-Griou, on account of the violence of the wind. My brother-in-law M. Nivet, who was at the Mont Dore, did not perceive the wind at the Pic de Sancy till midday, and I myself, upon the top of Puy-du-Dome, did not perceive its violence till one o'clock, and it was then only that the hail clouds arrived.

Perhaps I may have dwelt somewhat too much in detail upon these phenomena of which I was an eye witness, but I believe I have collected some facts which are new to meteorology, a science which is not very rich in them even at the present day. I shall conclude by endeavouring to sum up, without, however, considering them as quite general, the observations which I have collected on the two occasions I have specified.

### *Conclusions.*

1st. It appears that hail is formed during the prevalence of winds of *impulsion*, and not of those of *inspiration*, which, however, are generally more violent than the former. The storm of the 13th July, 1788, concerning which M. Tassier made a report to *L'Academie des Sciences*, goes to confirm this opinion. Its velocity was nearly the same as that of July 28, 1835.

2d, Two strata of clouds, placed the one over the other, and two winds from different quarters, seem necessary for the production of hail.

3d, The hailstones do not pass from one cloud to another as Volta supposed; on the contrary, they advance with very great horizontal rapidity, and are urged forward by an extremely cold wind.

4th, Electricity nevertheless plays an important part in these phenomena, and, according to all appearance, the superior cloud supports the inferior, heavily loaded with hailstones, and probably in a state of opposite electricity. There is probably also electrical repulsion among the hailstones which form the anterior extremity of the cloud, and which there present the whirlwind-like phenomenon which is so remarkable, and which I have twice observed in the most distinct manner

5th, The hailstones do not strike against each other during their horizontal transport; and the noise which is heard, that rolling murmuring which is perceived at so great a distance, is owing to the combination of the individual sounds produced by each hailstone cutting the air with such swiftness. The clashing of any hailstones during their progress causes them immediately to descend.

6th, We are led to suppose that the hailstones are subjected to a rapid rotary motion, but my opportunities have not yet enabled me distinctly to see it.

7th, The formation of hailstones, and their increase, appear to be owing to cold produced by the evaporation at their surface, on account of their great velocity. The hot air into which the anterior edge of the cloud penetrates, leaves a portion of water deposited upon them, a part of which is evaporated, and thereby congeals the other part, and thus forms concentric layers round the nucleus; the wind unceasingly transports the hailstones into new portions of the air which is saturated with moisture, and the upper cloud supports them in their progress. But the lower cloud rapidly increasing in density, by degrees falls down, and separates itself, more especially on its anterior portion, from the electrical cloud which supports it, till it reaches that point in which the action of this latter is almost nothing. the hailstones being all electrified in the same manner then strongly repel each other, and present that violent agitation which is perceived at the surface of the earth, and which repels in all directions those hailstones which the wind reunites by imposing upon them its own direction.

8th, The presence of long crystals at the opposite poles of the hailstones of the 28th July, 1835, would indicate that those which were placed at the equator were destroyed during their descent by the rotary motion, or that this same movement hindered them from being formed upon the equatorial portion on account of their velocity, whilst they were easily grouped upon the poles.

9th. The water procured from the melting of the hailstones was far from being pure.

From this short review, we may see how necessary it is, especially in meteorology, to guard against too readily generalizing facts. We must first observe, and then observe again, and we must wait till favourable occasions again place us in circumstances where we may see well, and study well, before we propose theories which, like those of Volta, can be supported only upon the reputation of a great name.

CLERMONT, 1*st February.*

The account which we have just been reading, and the precise results which the author deduces from the facts of which he was an eye witness, appear to be of a nature calculated to throw much light on the still rather obscure subject—the formation of hail. As, moreover, they seem to agree with the view we have taken with regard to this phenomenon, we may be allowed, in concluding this article, to explain briefly the opinions which we have formed on the point.

Electricity, then, always accompanies the formation and fall of hail; but we are often asked if, in correct reasoning, this is a sufficient motive or admitting that the hail owes its existence directly or indirectly to the lectricity:—Is it not possible that the same cause which determines the formation of the hail, at the same time developes the electricity, and that these two phenomena, instead of being connected as cause and effect, have no other alliance than that which depends on their having a common cause? The new opinions upon electricity with which science has within these few years been enriched, and more especially those which have obtained concerning the different circumstances in which this element may be developed, seem to confirm this conjecture; they seem also to derive a new degree of strength from the observations which have been made by M. Lecoq, and we shall therefore endeavour to develop our views.

The propagation of heat in any body is always accompanied by a development of electricity; and so far as there is any difference of temperature between the different parts of a body, so far is there a rupture of the natural electrical equilibrium. Now, if we consider a vertical column of atmospheric air during a serene calm, when no wind or cloud affects its physical condition, it will represent a body in which the temperature goes on decreasing from the base, which rests upon the earth, to its summit, which is the limit of our atmosphere. The difference of the temperature at the two extremes of this column must be very considerable, since it is admitted that the temperature of the atmosphere at its upper limit is at least —50° Cent. This difference ought also to be greater in summer than in winter, and in hot than in cold countries, since the temperature of the base of the column of air is determined by that of the soil upon which it reposes, whilst the temperature of its summit, being that of the limit of the atmosphere, is every where and at all times the same. This difference of temperature, which extends itself uniformly between all the points of the vertical mass of air, is necessarily the result of a continual propagation of heat from below upwards, and should consequently be accompanied by a development of electricity, the intensity of which should be increased in proportion as it ascends, that is to say, in proportion as the difference of temperature becomes greater. Now this is precisely what we learn from direct observation; we in truth find that the atmosphere, when it is calm and serene, is charged with a positive electricity, whose intensity is continually greater as we ascend. As to the negative electricity, which should accumulate at the base of the column, it is absorbed by the earth; for many observations of various kinds, and amongst others those of De Saussure and of Volta, demonstate that the earth is endowed with a negative electricity.

Taking, then, this view of the matter, which reposes solely upon experiment, and perfectly accords with what we discover in a body heated at one of its extremities, the permanent electrical condition of the atmosphere will essentially depend on the manner in which the heat is distributed, and propagates itself throughout the air, and not upon evaporation, vegetation, or any other cause variable in intensity, and unequally distributed, to which the atmospheric electricity has been erroneously, as we think, attributed. It would be easy to demonstrate that this explanation can account with the greatest accuracy for the variations which atmospheric electricity undergoes; and in particular that it is not in opposition to the fact observed by M. De Saussure, and after him by other naturalists, that this electricity is stronger in winter than in summer. In truth, the greater intensity of atmospheric electricity during the winter is owing to this circumstance, that the electroscope, by means of which we perceive it, is at this period of the year put into communication with a larger portion of the atmosphere, on account of the moisture with which the air is then almost always saturated.

Should the atmosphere cease to be serene, or should a mass of air loaded with humidity, and carried by the wind, happen, by its mixture with another mass of air, to produce clouds, immediately a new distribution of temperature, and consequently of the electrical condition of the column of air, would be effected. To comprehend this result, we must remember that the solar rays which heat the surface of the earth traverse the atmosphere without sensibly heating it; and that it is the heat emanating from the earth which essentially determines the calorific state of the atmosphere. Now when a vertical column of atmospheric air is divided into two sections by a layer of vapours, or by a cloud more or less thick, the terrestrial heat, not being able, at least wholly, to traverse this layer or this thick cloud, is sent back towards the earth whence it came, instead of penetrating through and beyond it. The portion of the column comprehended between the cloud and the soil preserves, therefore, this heat, whilst the portion included between the cloud and the limit of the atmosphere receives little or no heat; and the more the former of these two portions becomes hot, the more the second must be cold. Thus the column, instead of exhibiting a gradual decrease of temperature from its base to its summit, is found to be divided into two portions, having each a uniform, but very different, temperature. The cloud, more or less thick (or there may be many of them superposed on each other) which separates the two portions, is then very warm on its inferior surface, and very cold on its upper surface. It must, of course, be very strongly electrified, negatively on the one side, and positively on the other; and this electrical condition may be constantly destroyed by the neutralization of the two opposite electricities, which operate across the cloud itself, without however ceasing to exist, since the cause which produces it continues to act, and is ready to reproduce it as rapidly as it disappears. Here, then, we perceive the two strata of clouds of which M. Lecoq speaks; the wind ere long separates them; the atmosphere is speedily filled with clouds, some of which are negatively electrified, and the others positively, without including those which are electrical through the influence of others.

But why, it may be inquired, does this distribution of temperature, which produces so great an accumulation of electricity in the atmosphere, for the most part also produce the phenomenon of hail? In answer to this question, we must recollect, that the thicker the layer of clouds which intercepts the heat from the earth, the colder is the upper portion of the atmospheric column. Its temperature ought to be decidedly inferior to that of ice, for if the cloud completely interrupted all the terrestrial heat, it would be reduced to the temperature of the upper limit of the atmosphere, which is less than —50° Cent.; but there is no necessity it should be so low as this. It is enough that its temperature should be sufficiently low to congeal the drops of water at the upper part of the cloud, and so to freeze them as to render them capable, when impelled by the wind, as noticed by M. Lecoq, to traverse the layers of clouds, and descend towards the earth in consequence of their weight, at the same time condensing and freezing upon their surface the vapours through which they pass. Thus, the same cause which favours the abundant accumulation of atmospheric electricity in the cloud, will also be that which most assuredly effects the formation of hail. In particular, the immense heat which is usually experienced before a thunder storm, precisely indicates the existence of an invisible stratum, or of a cloud which, placed in some part of the atmosphere above the observer, intercepts the terrestrial heat, and sends it back whence it comes, instead of allowing it to proceed into free space; consequently, the higher the temperature is raised on the surface of the earth at any given time, the more it must be depressed on the other extremity of the column, or on the other side of the cloud, and consequently there must be the greater tendency both to the development of electricity, and to the formation of hail.

Again, the hailstones once formed, enlarge more or less, according to the length of the course which the wind causes them to pursue through the atmosphere; according to the quantity of water which they meet with in this course, and, finally, according to the temperature more or less low which they possess at the moment of their formation. In winter, if they be small, it is owing to the absolute quantity of water which the atmosphere contains being much less; and since at the moment of their formation the temperature is not lower than in summer, they must clearly condense a smaller quantity of water upon their surface, since they encounter less in their passage: they then form what we call *hoar-frost* (gresil.)

We believe, therefore, that hail is formed in the most elevated regions of the atmosphere; where we besides know, from the appearance of halos, that small crystals of ice are often floating. The cloud which carries these small nuclei of hailstones on its upper surface descends obliquely towards the earth through the combined effect of its weight and of the dominant wind. In proportion as it descends, the hailstones increase in size, or diminish and are dissipated, according as they meet in their course clouds, or a dry atmosphere. In the former case, the cloud which conveys them becoming always more and more weighty, at length descends lower than all the others, as has often been remarked, and finally disperses itself upon the ground.

We shall not attempt at present to develope more in detail the ideas which we have now expressed. We should even have waited till a greater number of observations than those which we have already made had furnished us with a more solid groundwork, had not the publication of M. Lecoq presented a favourable occasion for their publication.

Edin. New Philos. Jour.

## Mechanics' Register.

### *Cuir mâché.*

Mr. Joseph Esquilant, 25, St. Alban's Street, Lambeth, has recently invented a mode of manufacturing flowers, and other articles for decorating rooms, of leather, prepared in the same manner as paper is for *papier mâché.* The advantage of using this material is, that the articles are tougher and more durable. A specimen, which was shown to us by Mr. Esquilant, was thrown from one end of the room to the other and pulled at both ends with considerable force, without suffering the slightest injury. We trust some eminent architect will examine this invention, and patronize its author as he deserves.—*Cond.*

Architec. Mag.

## *The Cuba Railway.*

This railway passes from the city of Havanna to the port of Batabano, on the southern side of the island of Cuba, and is eighty miles in length. The purpose for which it has been constructed, is to connect the commerce of the Havanna and the northern side of the island, and also the commerce of New Orleans and various other important parts of the northern side of the Gulf of Mexico, with the West India islands and the Spanish Main. Cuba being an island of upwards of 700 miles in length, but only about 80 miles in average breadth, and lying in a position which requires vessels from the north or the south to sail round it in order to reach the opposite sea, it was projected by the present governor of the island, that a railway should be formed for the purpose of cutting off a navigation of several days, by passing across the island from north to south. It is therefore apparent that the railway is a work of the most important kind, and will tend to improve most materially the commerce, not of the island of Cuba alone, but of the English West India Islands, and of all the countries of the West India seas.

The railway is not perfectly direct in its course from the Havanna to Batabano; as, in the commencement of the undertaking, it was thought expedient to carry the line a few miles eastward of the due course across the island, for the purpose of taking in some very rich and populous villages and sugar plantations which exist upon the way. This deviation, however, will serve as a branch, should the traffic upon the railway prove equal to the expectations of the government, and the course, at a future time, be required to be rendered perfectly direct from sea to sea.

Fifty miles of the line have been completed some months since, and a steam locomotive engine, of great power and size, has been manufactured for it, by the Messrs. Braithwaite, of the New Road. The whole of the levels and other more important works upon the remaining thirty miles, are now also completed; and the rails having been shipped from England about two months since, it is expected that the next arrivals from the Havanna will communicate intelligence of the opening of the entire line.

Lond. Mech. Mag.

## *East India Caoutchouc.*

It is well known that a large supply of this valuable substance might be procured from India, if the same care were to be taken in gathering it as in South America. "The London Caoutchouc Company," impressed with this idea, accordingly sent to India an offer of a premium of fifty pounds for the first hundred weight of East India caoutchouc which should be shipped for England. When the offer arrived, however, it was somewhat of the latest; the great demand existing at home for the article had been previously heard of, and large quantities were already on shipboard; compared to which the "hundred weight" stipulated for was but a molehill to a mountain! The whole affair forms an apt illustration of the doctrine that, in commerce, the force of self-interest is far superior to that of artificial bounties. Ibid.

## *Minerals in Jamaica.*

The expectations of the Spaniards, which appear to have been disappointed on the first discovery of Jamaica by Columbus, with respect t its mineral riches, appear to be on the eve of being realized, in our days, after an interval of more than three centuries; specimens of copper, gold, silver, lead, and iron ores, of great beauty and richness, having been received in this country from an estate in the vicinity of Kingston. The copper ore is said to yield fifty per cent. of pure metal, and hence appears to be the richest in the world: and a cargo of copper ore shipped from an estate in the parish of St. George, sold as high as £40 per ton. Besides this, a discovery of coal, of excellent quality, has also taken place, and promises to be of vast advantage to the inhabitants.

Mining Journal.

## *Origin of Coal.*

Coal is supposed by some writers to be the remains of antediluvian timber which floated in the waters of the deluge until several mineral strata had been formed; others conceive it to be antediluvian peat bog. It was used in England anterior to the reign of Henry III; for that monarch, in 1234, renewed a charter granted by his father to the inhabitants of Newcastle, by which they were permitted to dig coal on the payment of 100*l.* per annum. Coals had been introduced into London before 1306, for in that year the use of them as fuel had been prohibited, from the supposed tendency of their smoke to corrupt the air. About the beginning of the sixteenth century the best coals were sold in London at the rate of 4s. 1d. per chaldron, and at Newcastle no more than 2s. 6d. for the same. During the ensuing century, however, they were received into such general use, that in 1648, on the scarcity of coal in London, many of the poor were said to have died from the want of fuel. The whole quantity of coal sent into London on an average of four years, has been estimated at 1,170,000 chaldrons per annum. There has been much dispute on the origin of coal, but Brogniart has given the following as the general conclusions of naturalists:—1. That coal was formed at the same time as, or after the existence of, organized bodies. 2. That this mineral when first formed was liquid, and in a great degree of purity. 3. That the same cause which produces this substance is several times renewed in the same places and under the same circumstances. 4. That the cause, whatever it may be, is nearly the same over all the earth, since the beds of coal always exhibit nearly the same phenomena in their structure and accidental circumstances. 5. That these beds have not been deposited by any violent revolution, but on the contrary, in the most tranquil manner, since the organized bodies that are found in them are often found entire, and the leaves of vegetables impressed in the slate which covers the coals are hardly ever bruised or otherwise deranged.—*Merthyr Chronicle.* Ibid.

## *Lunar Occultations for June* 1838.

| LUNAR OCCULTATIONS FOR PHILADELPHIA, JUNE 1838. | | | | | Angles reckoned to the right or westward round the circle, as seen in an inverting telescope. ☞ For direct vision add 180° ☜ | |
|---|---|---|---|---|---|---|
| Day. | H'r. | Min. | Star's name. | Mag. | from Moon's North point. | from Moon's Vertex. |
| 9 | 15 | 54 | Im. 84 p. Sagittarii | ,6, | 110° | 131° |
| 9 | 16 | 6 | Em. | | 286 | 319 |

## *Meteorological Observations for December,* 1837.

| Moon. | Days. | Therm. | | Barometer, | | Wind. | | Water fallen in rain. | State of the weather, and Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | Sun rise. | 2 P.M. | sun rise. | 2 P.M. | Direction. | Force. | | |
| | | | | Inch's | Inch's | | | Inches. | |
| | 1 | 39 | 56 | 30.10 | 30.10 | S. | Moderate. | | Fog—clear. |
| | 2 | 43 | 62 | 29.90 | 29 80 | S.W. | do. | | Fog—clear. |
| | 3 | 54 | 58 | 54 | 54 | W. | do. | | Cloudy—do. |
| ☾ | 4 | 39 | 45 | 80 | 84 | W. | do. | | Cloudy—clear. |
| | 5 | 30 | 42 | 30.15 | 30.20 | W. | do. | | Clear—clooudy. |
| | 6 | 29 | 45 | 20 | 10 | W. | do. | | Clear—do. |
| | 7 | 30 | 43 | 5 | 5 | W | do. | | Clear—do. |
| | 8 | 32 | 48 | 29.81 | 29.70 | W. | Brisk. | | Clear—do. |
| | 9 | 20 | 21 | 30.00 | 82 | E. | Moderate. | | Cloudy—do. |
| 🌑 | 10 | 30 | 32 | 29.50 | 50 | E. | Brisk. | .35 | Rain—cloudy. |
| | 11 | 32 | 34 | 50 | 60 | W. | do. | | Clear—cloudy. |
| | 12 | 28 | 37 | 90 | 90 | W. | do. | | Clear—clear. |
| | 13 | 27 | 40 | 90 | 80 | W. | Moderate. | | Clear—do. |
| | 14 | 24 | 32 | 80 | 80 | W. | do. | | Cloudy—clear. |
| | 15 | 18 | 27 | 30.00 | 30.00 | NW. | do. | | Clear—do. |
| | 16 | 19 | 30 | 20 | 20 | W. | do. | | Clear—cloudy. |
| | 17 | 22 | 29 | 10 | 29.00 | E. | Blustering. | | Snow—sleet. |
| ☽ | 18 | 52 | 43 | 28.90 | 10 | SW.W. | do. | 2.00 | Rain—shower |
| | 19 | 30 | 36 | 29-60 | 60 | SW. | Moderate. | | Clear—cloudy. |
| | 20 | 25 | 30 | 70 | 70 | W. | Brisk. | | Clear—do. |
| | 21 | 20 | 27 | 80 | 83 | W. | Moderate. | | Clear—cloudy. |
| | 22 | 20 | 30 | 90 | 30.00 | W. | do. | | Clear—partially cloudy. |
| | 23 | 19 | 32 | 30.25 | 25 | W. | do. | -3 | Clear—snow, |
| | 24 | 27 | 34 | 5 | 29.95 | NW. | do. | | Cloudy—clear. |
| | 25 | 27 | 36 | 15 | 30.15 | W. | do. | | Clear—do. |
| | 26 | 33 | 50 | 29.85 | 29.85 | W. | do. | | Cloudy—clear. |
| | 27 | 23 | 34 | 30.30 | 30.30 | SE. | do. | | Clear—do. |
| ⊗ | 28 | 23 | 39 | 29'96 | 29.96 | E. | do. | | Partially cloudy—do. do. |
| | 29 | 24 | 32 | 30. 5 | 30. 5 | SW. | do. | | Clear—lightly cloudy. |
| | 30 | 29 | 46 | 29.96 | 60 | W. | do. | | Clear—clear. |
| | 31 | 35 | 41 | 30.00 | 10 | ENE. | do. | | Clear—do. |
| | Mean | 29.13 | 38.45 | 29.90 | 29.86 | | | 2 38 | |

| | | Thermometer. | Barometer. |
|---|---|---|---|
| Maximum height during the month. | | 62.00 on 2nd. | 30.30 on 27th, |
| Minimum | do. | 18.00 on 15th. | 28.90 on 18th. |
| Mean | do. | 33.79 | 29.83 |

# JOURNAL

OF THE

# FRANKLIN INSTITUTE

OF THE

State of Pennsylvania,

AND

MECHANICS' REGISTER.

MAY, 1838.

## Practical and Theoretical Mechanics and Chemistry.

*Extracts from "Researches as to Lime-burning. By* M. Petot, *Engineer of Roads and Bridges.* Translated from the French by J. G. Totten, Lt. Col. of Eng. and Brevet Col. United States Army.*

### Article xvii.—*On the preparation of Factitious Puzzolanas, and particularly of that afforded by Gneiss Sand.*

### §1. *On different kinds of Puzzolana.*

The important part that puzzolanas play in the improvement of hydrualic mortars, sufficiently explains the interest that belongs to an examination of this subject. As yet we know of no other means of forming mortars susceptible of hardening in water: and even since hydraulic limes have become the subject of particular study, that of puzzolanas has not been the less attended to, because hydraulic limes are not to be found in every locality, nor is it always possible, or economical, to manufacture them; and because in many circumstances they give mediocre results only, unless mixed with a certain dose of puzzolana.

Puzzolanas may be arranged in two principal classes, namely, natural puzzolanas, and artificial puzzolanas. Among the first, the most energetic are, generally, volcanic matters of a composition analogous to clays. These were discovered first in Italy, where their use goes back to time immemorial. Afterwards they were found in countries possessing extinct volcanoes, as Auvergne, Vivarais, Guadeloupe, &c. The matters which furnished them have sustained, by igneous action, a change in the primitive mode of combination in their elements; but as the intensity of this action was not every where the same, there resulted products of various degrees of cohesion: and it is not difficult to conceive that great differences may exist in their qualities, although none may exist in their chemical composition.

It may, nevertheless, be possible that a puzzolana is no more than of medium quality, merely because, as is said in common parlance, it is still *too*

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*Paris, from the Royal press, 1833.

*young.* In cases where there was at first too much cohesion, certain influences may, in the course of time, bring about a state of disaggregation. This phenomenon is not without example in nature: the greater part of the feldspathic rocks are in these circumstances, and produce a second variety of puzzolanas. Such, particularly, are the graywackes of Carhaix, the arenes of Perigord, and our gneiss sands. The geological position of these substances, at least of the gneiss which we have before us at Brest, does not admit the supposition of any igneous action. This disaggregation goes on little by little, and we take, as it were, nature in the act, for between the upper parts of the quarries which are in a state of sand, and those which are still in the condition of hard rocks, it is not rare to find a series of layers of every intermediate grade of cohesion.

These recent puzzolanas are but slightly energetic: but by torrifying them, they are rendered, if not equal to the first, at least applicable to almost all the same uses: they thereby pass into the class of artificial puzzolanas.

In the same class we must also arrange, after they have been highly calcined, compact schists, and even basalts. Calcination was, in fact, the means applied to these substances by M. Gratien Lepère, and the Swedish engineer Baggé. Lastly, all clays, considered either as proceeding from the decomposition of rocks, or as forming particular earths, lead to the same result by the application of heat.

Few localities are without clays; whence the general use, from very remote periods, of the dust of bricks or tiles, as cement. We may now substitute, with economy, the sands of graywacke, of gneiss, and of arenes; but these latter substances are less common. By their use the subject does not change its aspect; there is merely an enlargement of its boundaries.

In all puzzolanas, natural or factitious, the elements of clay, namely, silex and alumine, determine the hydraulic qualities: moreover, silex alone, in jelly, or lightly calcined, but in a state of extreme division, gives, by its mixture with fat lime, a good hydraulic mortar; while it is not the same with alumine; we may, therefore, say, definitively, that silex is the base of all puzzolanas; and that, reciprocally, all substances containing silex in a state of feeble cohesion are apt to become puzzolanas.

### §2. *On several methods employed in the preparation of Factitious Puzzolanas.*

The study of the quality and use of natural puzzolanas not having immediate connexion with the question before us, we shall restrict our remarks to artificial puzzolanas. And we shall first refer to the several methods applied to their preparation.

The material to which recourse is had, may be submitted to heat, first, in the state of powder; and second, in the state of fragments, either brick shaped, or of irregular forms. In the first case, all refractory, ochreous, or calcareous, clays may afford good puzzolanas by a torrefaction of a few minutes. It will be sufficient to spread the powder in a thin layer on an iron plate, and keep it incandescent from five to twenty-five minutes. M. Vicat, to whom we are indebted for the knowledge of this method, adds, however, that it has not been applied on a large scale, and that it offers some difficulties. M. Girard de Caudembourg assures us, from his own experiments, that when the arene sands have been lightly torrefied, the time required to set under water is shortened, but the hardness of the mortars is not increased. This consequence, founded on a particular case of calcination, does not prove that it is true in general of arenes, more than of graywacke or gneiss.

In the second case the materials are employed either pure, that is to say, in the state nature supplies them, or previously mixed with certain substances designed to facilitate the chemical reaction. This premised, we see, according to Gen. Treussart, that calcareous clay brought to the same degree of calcination as lightly burned bricks, gives good results; and that from this degree up to that of the highest calcination, its energy rapidly diminishes, and at last becomes null; that for ochreous clays, on the contrary, the calcination of lightly burned bricks gives very mediocre results; but that these results are progressively ameliorated up to the degree of burning required to produce good bricks, beyond which it decreases indefinitely; that, lastly, refractory clays also give excellent puzzolanas at the degree of burning which makes good bricks, but they resist better than the ochreous clays the effect of a higher calcination, and do not sensibly lose quality up to a calcination equalling that of common lime. It is, consequently, to be supposed that they attain their maximum less quickly; and such is, without doubt, the reason why Chaptal—submitting to the same mode of calcination refractory clay, sometimes pure, and sometimes mixed with the sulphate of iron, which gave the equivalent of an ochreous clay, found different results, and concluded that the oxide of iron was an element essential, generally, to the success of the operation.

Clays, at the same time ochreous and calcareous, but containing at least a tenth of their weight of lime, like clays simply calcareous, require only a slight calcination. (Treussart.) We may thus, by a slight burning, obtain good puzzolana with an ochreous clay, by impregnating it with a certain quantity of lime, according to the recommendation of Inspector General Bruyère. We might also, with equal success, replace the lime by potash or soda; and such, for example, is what is called *aquafortis cement*, a residue left in the preparation, by means of clay and nitrate of potash, of nitric acid.

At the works on the canal from Nantes to Brest, graywacke, in irregular pieces, was submitted to a degree of heat like that required to furnish good bricks. And, according to M. Vicat, blue schist requires to be heated till it swells up, (*boursoufle*,) and basalt till it melts, (*le basalt doit couler.*)

For the burning of all these materials in fragments, lime kilns or brick kilns may be used. Unfortunately, the uniformity of the burning not being perfect in any of these kilns, fragments are mixed together, some of which are too much, and some too little, burned; and, consequently, there is a mixture of good and bad puzzolana, affording a mediocre result, or at least a result quite inferior to what may be obtained in the laboratory.

If to this be added, the expense necessary to pulverize and sift these same fragments, it will be perceived how important it is to be able to apply on a large scale M. Vicat's method; for with that method nothing is easier than to arrive at a uniform degree of calcination; after which the products need no manipulation. Such was the object in view in constructing the furnace described below. The abundance of the gneiss sand in the quarries of the port of Brest enabled us to avoid the expense of a preliminary pulverization, and at the same time we were enabled to turn to profit the immense quantity of wood chips furnished by the naval constructions.

*Note. Then follows in the original:*

*Description of a furnace for factitious puzzolanas.*

*Details relative to the various parts of the furnace.*
*Progress of burning.*
*Quantity of products obtained.*

*The furnace being a reverberatory, the cement was spread out upon the hearth in undulating zones, rather thicker near the front than in the rear, or on the sides, and the aperture was closed for twenty to twenty-five minutes. At the end of this time the surface submitted to the flame was renewed, by turning over the substance. Waiting about another twenty minutes, the calcination was sufficient, and the matter was drawn away to give place immediately to another portion. The author then proceeds:*

The quantity of puzzolana prepared in this way varied as the furnace was more or less hot; but it became constant after the fifth or sixth day, and amounted regularly to 120 cubic feet in 24 hours. The number of burnings in the same interval was 34; which gave for each burning 3.53 cubic feet of puzzolana and 42 minutes of time.

The first days the furnace was in operation, we withdrew as much as 177 cubic feet in 24 hours. But experience was not slow in demonstrating that too much in quantity was injurious to the quality; and, which is remarkable, this imperfectly burned sand was less energetic than the crude sand. It was not less important to prove, on the other hand, what would happen in prolonging the calcination beyond 42 minutes. To this end, two new essays were made, the one with two hours', and the other with three hours' burning; and we found that under these circumstances, the energy of the puzzolana suffered a little as respects the rapidity of the setting, but remained about the same, as to resistance to rupture, at the end of fifteen months.

It was important to have, as a term of comparison, some trials of the gneiss burned in the state of fragments, according to the process antecedently used. For that purpose we took, at hazard, a considerable stock of powder reduced from fragments burned during twelve to fifteen hours in a lime kiln; and other powder reduced from fragments burned above the lime, in another lime kiln. With the first, the results were inferior to those with the crude sand; with the second, they were sensibly better than the crude sand, but weaker, notwithstanding, than the sand calcined in the reverberatory furnace.

### §3. *Comparative experiments with the Puzzolana of Gneiss, taken in different conditions.*

The experiments here mentioned are united in the two following tables.

Table No. XLIII.—*First series of experiments.*

| No. | Composition of the mortars. | Time required to set. | Resistance to rupture per 0,394 inch (centimetre) square. | Age of the mortars when broken. | Remarks. |
|---|---|---|---|---|---|
| | | d's. | lbs. | mo's. | |
| 1 | One of lime in paste with two of crude gneiss sand . | 20 | 2.35 | 8 | Immersed in sea-water. The time of setting, a little uncertain on account of the surface swelling up. |
| 2 | Same with two and a half . | 20 | 3.23 | do. | |
| 3 | Same with two of sand slightly calcined . . | 35 | 2.04 | do. | |
| 4 | Same with one of sand do. and one of quartzose sand | ? | $<0.77$ | do. | |
| 5 | Same with two and a half of gneiss sand calcined for 42 minutes . . | 7 | 5.37 | do. | The resistances to rupture were calculated generally after the formula of Galileo, $2\ Pc = R\ a\ b^2$ wherein P indicates the weight that caused the rupture; $c$ the distance of the point of support of the mortar to the point of application of the load; $a$, the breadth of the prism, and $b$, its depth. |
| 6 | Same with two do. . . | 7½ | 5.37 | do. | |
| 7 | Same with one and a half do. | 8 | 4.03 | do. | |
| 8 | Same with one do. and one of quartzose sand . | 20 | $<0.99$ | do. | |
| 9 | Same with two of pulverised fragments having been heated from twelve to fifteen hours in a lime kiln . | 34 | 2.11 | do. | |
| 10 | Same with one and a half of the same puzzolana . | ? | $<0.97$ | do. | |
| 11 | Same with one of do. and one of quartzose sand . | ? | $<0.75$ | do. | All the mortars comprised in this table were immediately immersed in sea water. |
| 12 | Same with two of pulverized fragments heated more highly than the above . | 8 | 3.43 | do. | |
| 13 | Same with two of do. from another fragment, . | 7 | 4.69 | do. | |

Table No. XLIV.—*Second series of experiments.*

| No. | Composition of the mortars. | Time required to set. | Resistance to rupture per 0.394 inch (centimetre) square. | Age of the mortar when broken. | Remarks. |
|---|---|---|---|---|---|
| | | d's. | lbs. | m's | |
| 14 | One of lime in paste with two of gneiss sand calcined for forty-two minutes | 8 | 5.19 | 15 | Tempered stiff and immersed immediately in fresh water. |
| 15 | Same with two of sand calcined during two hours | 12 | 5.70 | do | |
| 16 | Same with two of sand calcined during three hours | 20 | 5.76 | do | |
| 17 | Like No. 14, but tempered very soft and immersed immediately in fresh water | 24 | 3.04 | do | |

Table No. XLIV—Continued.

| No. | Composition of the mortars. | Time required to set | Resistance to rupture per 0.394 inch (centimetre) square. | Age of the mortar when broken. | Remarks. |
|---|---|---|---|---|---|
| | | | lbs. | mo's | |
| 18 | Like No. 15 but a little less soft than No. 17 | 16 | 8.96 | 15 | It is remarkable that under fresh water the mortars have not the same tendency to swell up as in sea-water. |
| 19 | Like No. 16 and about the same consistence as No. 18 | 20 | 4.70 | do. | |
| 20 | Like No. 14 but allowed to dry for 18 hours before the immersion | 12 | 6.60 | do. | |
| 21 | Like No. 15 and with the same precaution as No. 20 | 11 | 7.17 | do. | |
| 22 | Like No. 16 and with the same precaution as Nos. 20 and 21 . . . . | 13 | 6.60 | do. | |

### §4. *On the influence of the inert portions of gneiss sand.*

The trials Nos. 4, 8 and 11 indicate that the puzzolana of gneiss will not bear any addition of quartzose sand: all the other numbers indicate that when calcined properly it gives mortars that set very soon under salt water or fresh water, but that it acquires in the end, only a moderate hardness. In fact, it can be arranged only in the class of puzzolanas *simply energetic*.

All these results appear to us to be affected by one and the same cause, the presence of inert matter. We know that gneiss, like granite, is formed of quartz in grains, mica and feldspar: but the quartz totally resists spontaneous decomposition; the mica resists it in part, because it is that substance which is seen in the sand of the quarry in countless brilliant spangles: the feldspar alone undergoes chemical alteration, and furnishes the active element of puzzolana. The energy of this puzzolana depends then on the relative quantities of feldspar on the one hand, and of quartz and mica on the other. Several attempts at a separation have given us a mean proportion of about one quarter for the quartz. The mica is much more abundant but difficult to separate. On collecting, by means of a very fine seive, the most pulverulent portions of a well burned sand, it appeared to be extremely charged with mica; and on tempering it with lime in paste, it gave a mortar which did not indurate in water till the end of 24 days; while with the same sand not sifted, the setting of the mortar occurred at the end of the 7th day.

We will add that the proportions of constituents may vary, from one quarry to another, or even in different veins of the same quarry. It was thus, probably, that on one occasion, the calcined sand, taken at hazard from the store house, gave us—*time of setting, five days—resistance to rupture per* 0.394 *inch, (centimetre) square*—11.22 *lbs.—age of the mortar when broken* 5½ *months*.

The energy of the products obtained from the reverberatory furnace appears then to depend quite as much on the substance used as on the degree of calcination given to it.

### §5. *Trials of the same reverberatory furnace in the calcination of plastic clays.*

What we have thus far said of the gneiss sand is applicable, for the greater part, we do not doubt, to graywacke sands and to arenes; but circumstances have not permitted us to verify it.

Plastic clays have the advantage of these feldspathic rocks, in not being mixed with matter essentially inert; in this respect they offer more chances of being converted into very energetic puzzolanas. But can they be treated with success in the reverberatory furnace? We wish to clear up this question, by some trials, of which we will proceed to give an account.

We made use of the common clay of Brest, which is ochreous and eminently plastic. After having cut it into small slices by means of a wire, and having dried these little slices in the air, they were reduced to powder, or rather they were ground, in an apparatus, of which a description would be useless at this time, but which may be said to be founded on the same principle as a *coffee-mill.* The clay brought to this state was introduced into the furnace, as the gneiss sand had been, and was heated with the same kind of fuel, first for forty-two minutes, then for two hours, and afterward for three hours. We had thus three kinds of puzzolana, which, used in the fabrication of mortars, gave:

*The* 1*st. an imperfect hardening--a tendency to form paste with water*;

*The* 2*nd. hardened in twenty days—resistance to rupture after fifteen months*, 3.17 *lbs;*

*The* 3*rd, hardened in eleven days, resistance to rupture after fifteen months*, 6.86 *lbs.*

*At the same time we found:*

*That with puzzolana from well burned square tiles, the hardening took place in* 7 *days; and the resistance to rupture, after eight months, was* 14.30 *lbs: that with puzzolana from Italy, the hardening took place in seven days, and the resistance to rupture, after eight months was* 16.35 *lbs.*

Whence we see that the degree of heat afforded by our reverberatory furnace is insufficient to give to plastic clays all the energy of which they are susceptible. It might be otherwise if we were to use a better fuel: but it is not the less demonstrated that, as regards calcination, we cannot place gneiss sands and plastic clays in the same list. As to these last, one consideration is striking; which is, that if the calcination be not perfectly uniform, all those portions which retain a tendency to form paste with water, will become an obstacle to the setting of the mortar, and a permanent cause of alteration. The gneiss sands, on the contrary, act even in their natural state, like puzzolana; and, in the most unfavourable case, give a mixture of portions, only more or less active.

### §6. *On calcination on a small scale, upon thin iron plates.*

The results we have just been exposing do not at all conform to the manner in which the preparation of factitious puzzolanas, by heating pulverulent substances on plates of sheet iron, has been considered. *An incandescence for a few minutes—a very moderate burning*, compared to what is required in the burning of lime on a large scale, or even in the burning of bricks, carries with it the idea of a degree of heat easy to attain; and, consequently, of the necessity of a particular influence exerted by the contact of atmospheric air. It will not, therefore, be without interest to rectify this opinion by new experiments, which, besides, lead to some other remarks.

On exposing iron plates to the fire in a common fire place, the degree of heat obtained is too feeble: for the clay in powder, heated in this way during 10, 20, 30, 45, and 60 minutes, gave a puzzolana still forming paste with water, excepting the last, which was passible. Under the same circumstances, limestone reduced to powder, did not lose beyond 6 or 8 per cent. of its weight. In order to obtain greater heat, and to operate with more promptitude, we placed plates of sheet iron in a small forge over a fire of charcoal, we then found, for 100 grammes of powdered hydraulic limestone containing 33 per cent. of carbonic acid, duration of calcination—10 minutes—15 minutes—20 minutes—45 minutes: corresponding loss of weight —8.33 gms.—30.00 gms.—32.85 gms.—33.00 gms.

The last three specimens, sprinkled with water, slaked and swelled like ordinary lime just from the kiln. In a few minutes, therefore, the same effects are produced by ignition on a plate of sheet iron, as after several days of burning in a kiln.

To ascertain what would happen on replacing the powdered limestone by powdered clay, we made two series of experiments, one on gneiss sand, and the other on an ochreous clay: mortars were made of the resulting puzzolanas; and we deduced from the experiments the two following tables.

Table XLV. *Gneiss Sand.*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Duration of the calcination. | 0 | 3½′ | 5′ | 7½′ | 10′ | 15′ | 20′ | 40′ | 60′ | 120′ | B. It was not always possible to ascertain exactly the loss of weight, on account of the adherence of the sand to the iron. |
| Loss of weight on 100 grammes | | gms.<br>6.20 | g.<br>6.30 | g.<br>? | g.<br>7.30 | g.<br>? | g.<br>7.15 | g.<br>? | g.<br>? | g.<br>? | |
| Order in which the hardening under water occurred | 4 | 3 | 1 | 1 | 1 | 2 | 3 | 4 | 5 | 5 | The hardness was measured by the weight necessary to force into the mortar a wire 0.047 of an inch in diameter. |
| Hardness after two months. | Soft and without consistence | gms.<br>400 | g.<br>800 | g.<br>800 | g.<br>800 | g<br>800 | g.<br>500 | g.<br>300 | g.<br>250 | g.<br>180 | |

Table No. XLVI. *Powdered ochreous clay.*

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Duration of the calcination. | 5′ | 7′ | 10′ | 15′ | 20′ | 25′ | 30′ | 40′ | 60′ | 120 | The first two specimens were heated more violently than common. The clay adhered to the sheet-iron. |
| Loss of weight on 100 grammes. | ? | ? | gms.<br>9.50 | g.<br>9.65 | g.<br>1160 | g.<br>? | g.<br>12.20 | g.<br>12.50 | g.<br>? | g.<br>? | |
| Order in which the hardening under water occured | 4 | 3 | 3 | 2 | 1 | 1 | 2 | 4 | 5 | 6 | All the puzzolanas mentioned in these two tables, were of a decided red, except the first, which had the natural colour of the sand. |
| Hardness after 2 months. | gs.<br>900 | g.<br>1000 | g.<br>1000 | g.<br>1100 | g.<br>1500 | g.<br>1500 | g.<br>1200 | g.<br>600 | g.<br>500 | g.<br>200 | |

These tables show that the degree of heat necessary to convert ochreous clay into good puzzolana differs but little from that necessary to the complete calcination of lime, and may, consequently, be assimilated to that required to produce good bricks: that for the gneiss sand, as we have already shown, a much lighter calcination will suffice, and which, on a large scale, should not exceed the calcination given to slightly burned bricks. Nothing as yet shows the truth of the hypothesis, that the contact of the air exercises a particular influence on the calcination of any argillaceous substances whatever, on plates of iron. It is objected, it is true, that the same substances calcined in close vessels do not give the same results; but there is nothing in that which should surprise us, as we will attempt to prove.

### §7. *On calcination in Close Vessels.*

We operated in a melting furnace with crucibles of about 4¼ quarts: instead, however, of four hours' fire required for melting trass, we limited our fire to two hours. The first crucible containing gneiss sand, contained, besides, several small fragments of hydraulic limestone, weighing about ⅓ of a pound each, and so disposed, that after the exposure to the fire, we could ascertain, by their aid, as by a pyrometer, the relative intensities of the heat in different parts of the mass. We here see what happened.

1st. In the high and central parts of the crucible, the gneiss sand neither changed colour nor consistence: and the calcareous pieces lost only five or six hundredths of their weight.

2nd. In the enveloping layer, the sand, slightly agglutinated, had taken a pale gray slate colour; and the calcareous pieces, rather more burned than the preceding, gave a pellicle of lime which slaked in contact with the air.

3rd. In the more exterior layer, the sand had the consistence of the scoria of forges, and a decided slate colour. The calcareous fragments were found in the state of perfect lime, but without any indication of supercalcination, or any adherence to the matter surrounding them.

A second crucible, filled with ochreous clay, in powder, which had been dried at a low red heat, gave products altogether analogous; that is to say, gave three distinct species: one of the ordinary red colour, another of a deep purple, and a third of a slate colour.

In the transition from one to the other of these principal products, there necessarily existed a great many shades, difficult, certainly, to isolate, but which did not the less correspond to so many particular degrees of calcination. We may then conclude,

1st. That it is nearly impossible to obtain a homogeneous torrefaction in close vessels.

2nd. That if the substances employed are ochreous, their fusibility will manifest itself at a degree of heat less than that which is necessary for the calcination of lime; which does not happen when in contact with the air on plates of iron.

3rd. That consequently, in these two modes of preparation of puzzolana, the same degrees of heat do not correspond to the same chemical reaction.

4th. That, therefore, not having any thing but the appearance of the substances, to guide us in the choice of terms of comparison, we are liable to oppose to the best puzzolana prepared in contact with the air, another prepared in a close vessel, in which the chemical reaction of the elements is in a very different state of advancement: and this, whether the clay were ochreous, or simply composed of silex and alumine.

Thus then, as has been already seen, it might happen that two mortars made of different puzzolanas, would acquire, after a certain time, the same hardness without having had, nevertheless, the same promptness of induration. Thus we may say, further, that the variable proportion of alumine soluble in hydrochloric acid, is not a consequence of such or such a mode of calcination, but rather of the difficulty of seizing terms of comparison perfectly exact.

### §8. *On the decrease of the energy of Puzzolanas as they approach the point of vitrification.*

The phenomena which will be developed in the following article, taught us the importance of ascertaining whether the diminution in the energy of puzzolanas was progressive as the substances approached the term of vitrification. With this view we collected the preceding puzzolanas, prepared in close vessels, and bearing traces more or less evident, of vitrification. Making mortars of these, we remarked in the first place, that a very small addition of water sufficed to soften them in a singular manner. Be that as it may, the specimens obtained in stiff paste, were immersed the same day; the others were not immersed till the next day, in order to give them time to dry. After fifteen days none of them had acquired any kind of consistence; all being merely inert matter. With time, these results might change, no doubt, but they will not be the less inferior to those of §6.*

If, instead of substances containing the oxide of iron, we had employed those containing lime, potash, or soda, it may be presumed it would have been the same; because the substances we have named all act as fluxes with silex. Thus, therefore, in whatever manner the solidification of mortars may be explained, it is necessary to admit, that puzzolanas require to be deprived of water by heat, and not to have too great cohesion given to them. Whence it results that the most proper degree of calcination cannot be the same for all puzzolanas, but should vary, more or less, according as the substance employed contains more or less water, and a flux more or less energetic.

### §9. *The relation between the quality of Puzzolanas and some of their physical properties.*

In indicating the conditions necessary to obtain good puzzolanas, M. Vicat says, (*Résumé sur les mortiers,* page 33,) that the matter ought to have the minimum of specific gravity, and the maximum of absorbent power. If this were rigorously true, it would be an argument against the hypothesis of a chemical reaction in the solidification of puzzolana mortars. We believed it would be interesting to verify this opinion; and to that end, we made the several experiments exhibited in the following tables.

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*After a month, these mortars had not improved perceptibly. The specimens made of the puzzolana the most highly calcined were as soft as on the first day. Au.

Table No. XLVII.

| Gneiss sand, in several states of calcination. | Weight of substance submitted to experiment. | Weight of substance after 18 days' exposure in a dry place. | Weight of substance after 3 days' exposure in a humid place. | Weight of substance after 7 days' exposure in a humid place. | Maximum increase of weight for 100 parts of the substance. |
|---|---|---|---|---|---|
| | Grms. | Grms. | Grms. | Grms. | Grms. |
| Crude sand highly dried . . | 41.90 | 42·00 | 42·30 | 42.30 | 0.95 |
| Calcined for 3½ minutes . . . | 35.75 | 35.83 | 36.05 | 36.05 | 0.84 |
| Do. 5 do. . . | 35.50 | 35·60 | 35.80 | 35.80 | 0.84 |
| Do. 7½ do. . . . | 36.00 | 36·10 | 36.30 | 36.29 | 0.83 |
| Do. 10 do. . . | 34.50 | 34·60 | 34.75 | 34.75 | 0·72 |
| Do. 15 do. . . . | 33.75 | 33·86 | 34.05 | 34.04 | 0.80 |
| Do. 20 do. . . | 34·70 | 34·80 | 34.95 | 34.95 | 0·75 |
| Do. 40 do. . . . | 32.45 | 32.54 | 32.67 | 32.65 | 0.61 |
| Do. 60 do. . . | 32·30 | 32.39 | 32.52 | 32.50 | 0.68 |
| Do. 120 do. . . . | 30·25 | 30·44 | 30.55 | 30.55 | 0.66 |
| Calcined in a close vessel, a little melted, (un peu frìttée) . . . | 55.00 | | 55.20 | 55.15 | 0.36 |
| Do. do. more melted | 51.70 | | 51.80 | 51.75 | 0.20 |
| Do. do. still more melted | 49.90 | | 50.00 | 50.00 | 0.20 |

Table No. XLVIII.

| Ochreous clay in several states of calcination. | Weight of substance submitted to experiment. | Weight of substance after 18 days' exposure in a dry place. | Weight of substance after 3 days' exposure in a humid place. | Same after 7 days' exposure. | Same after 9 days' exposure | Maximum increase of weight for 100 parts of the substance |
|---|---|---|---|---|---|---|
| | Grms. | Grms. | Grms. | Grms. | Grms. | Grms. |
| Calcined during 5 minutes . | 26.55 | 26.59 | 26.85 | 26·95 | 26.94 | 1.50 |
| Do. 7 do. . | 27·00 | 27.17 | 27·45 | 27.54 | 27·54 | 2.00 |
| Do. 10 do. . | 32·45 | 32.49 | 32.90 | 33.05 | 33·04 | 1.85 |
| Do. 15 do. . | 32.15 | 32.20 | 32.65 | 32·74 | 32·72 | 1.77 |
| Do. 20 do. . | 29.20 | 29.22 | 29.58 | 29.63 | 29·65 | 1.52 |
| Do. 25 do. . | 31·70 | 31.75 | 32.03 | 32.12 | 32.15 | 1·40 |
| Do. 30 do. . | 29.65 | 29.70 | 29.95 | 30.03 | 30·05 | 1·33 |
| Do. 40 do. . | 29.25 | 29·26 | 29.50 | 29.57 | 29·57 | 1·08 |
| Do. 60 do. . | 36·70 | 36·74 | 37.05 | 37·20 | 37·20 | 1·36 |
| Do. 120 do. . | 19.00 | 19.04 | 19.20 | 19·25 | 19·25 | 1·31 |
| Calcined in a close vessel, a little melted, (un peu frìttée) . | 54.65 | | 54.74 | 54·80 | 54.76 | 0·27 |
| Do. do. more calcined | 55.40 | | 55.53 | 55.60 | 55·50 | 0·36 |

These two tables show, 1st, that puzzolanas exposed in a dry place have a very weak absorbent power; 2d, that this absorbent power augments, in a very sensible manner, in a wet place, a circumstance which renders the condensation of gas, admitted by some persons, but little probable; 3d, that this power is at its maximum before the gneiss sand or the clay had acquired the most advantageous degree of calcination; 4th, that it is not equal, by a considerable difference, in the two kinds of puzzolana, and in this respect it gives a tolerably correct idea of the relative energies; 5th, and lastly, that the vapour of water thus condensed does not enter into combination with the fixed matter, for it escapes, though in a small quantity, by a simple hygrometric variation in the atmosphere.

Experiments show that in taking bricks in several states of calcination, and immersing them in water, the proportion of liquid absorbed is greater for bricks but slightly burned, than for bricks more burned; that is to say, it is greater for bricks which give only a mediocre puzzolana, than for those which give a good puzzolana. The same experiments will also show that dry clay, before reaching the term of good burning, augments its volume in passing through the term of half burning; and that in this last state, the density of the brick is less than in the preceding. The maximum of energy, therefore, neither corresponds to the maximum of density, nor to the maximum of absorbent power.

## ARTICLE XVIII.—*On the Preparation—the Preservation—and the Use of Plastic Cements.*

### §10. *On Lime Stones which serve for the preparation of Plastic Cements.*

When a lime stone contains about twenty per cent., or more, of its weight of clay, it may furnish the substance known under the names of *plastic cement—Parker's cement—Roman cement.* This substance has the property of hardening very soon, like plaster of Paris; but it has also the further property of indurating under water, like the hydraulic limes. These plastic cements present characters so peculiar, in their preparation and in their use—they have, besides, acquired so high an interest in France since the creation of the establishment of Pouilly, that we have thought proper to appropriate to them a special article, the better to insist on several observations of which the importance will be easily seen.

Until within a few years, plastic cement was a production exclusively English. It was principally near the Thames that the stone, proper for its fabrication, was found. In 1802, similar stone was found on the sea shore, at Boulogne, but in rolled pebbles, and in too small quantity to become an object of regular preparation. It exists also at Baye, near Nevers, according to M. Vicat; in Russia, according to Messrs. Lamé and Clappeyron, and, no doubt, in many other localities; but up to the present time the researches of M. Lacordaire, at Pouilly, are the only ones which have produced very positive results, on a large scale, in France.

The stone from which the English cement is derived, appertains to the upper steps of the secondary, lias formation. It is ordinarily found in rounded masses in the middle of marley strata. That of Pouilly appertains to the same geological formation: such a coincidence leads us to conclude that this kind of formation is most favourable to new investigations. However that may be, the following are analyses of plastic cements already known:

| | | | | |
|---|---|---|---|---|
| English cement—carbonic acid deducted | 55.4 | of lime, | 44.6 | of clay. |
| Cement of Boulogne pebbles | 54.0 | do. | 46.0 | do. |
| Pouilly cement—first variety | 42.86 | do. | 57.14 | do. |
| The same—second do. | 36.37 | do. | 63.63 | do. |
| Russian cement | 62.00 | do. | 38.00 | do. |
| Cement of Baye | 21.62 | do. | 78.38 | do. |

### §11. *Mode of preparation followed by Parker.*

It was in 1796 that Parker first indicated the means of converting into cement, the very argillaceous lime stones found in roundish masses, and called *septaria.* His process consisted, essentially, in pushing the calcination of the stone to vitrification: and he took out, for his process, a patent in which are the following details:

"The stones are first broken into small fragments: then burned in a kiln as is commonly done with lime, at a heat sufficient to vitrify them; afterward reduced to powder by a mechanical or other operation. The powder thus obtained is the base of the cement. To compose this cement in the most advantageous manner, two parts of water are mixed with five parts of powder, and stirred and beaten to effect a mixture. The cement thus made ought to set or harden in ten or twenty minutes either in air or in water." (Extract of a report of M. Mallet to the *Société d'Encouragement.*)

Parker not having succeeded in his enterprise, and his process having been abandoned, it was generally supposed that he was mistaken, founding the opinion on what happens with fat lime too highly calcined. But here analogy fails, as we shall soon show by experiment.

### §12. *Mode of preparation followed by the successors of Parker.*

The plastic cement which now circulates in trade should not be designated by the name of Parker's cement, for there is a capital difference in the preparation. We are ignorant whether the successors of Parker have given a description of their process; but it is easy to judge of the means by the end. Their cement, in fact, treated with muriatic acid, causes a notable quantity of carbonic acid gas to escape. It has besides an ochreous colour resembling that of the natural stone, and differing much from that which may be given it by vitrification. There is no doubt, therefore, that the cement is formed of the septaria *incompletely calcined.*

As to the method followed by M. Lacordaire, M. Mallet, at page 12 of the report already cited, says:

"The stone is explored by blasting with powder in pits and galleries, at a mean depth of about 262 feet. The selection of stone is made above ground, where it is broken into pieces the size of the fist, and carried to the kiln, which is of the kind called *fours contans ou à feu continu* (continual fire.) The stone, when burned and brought to the state of lime, is ground under a pair of cast iron cylinders weighing about 5300 lbs. . . . . . . The cement is afterwards passed through sieves formed of iron wire separated 0.06 of an inch; by this first operation, a cement is obtained which is called No. 2. This is then passed through a bolting machine also formed of iron wire, but with finer meshes; and it is then called No. 1."

M. Mallet no where says that the cement is incompletely calcined; but it would be a mistake to suppose otherwise. It is, besides, easy to prove it; for the cement tried with acids, permits, as in the English cement, a notable quantity of carbonic acid to escape.

### §13. *As to what occurs to Plastic Cements at the point of complete calcination.*

We see from what precedes, that it is equally possible to obtain plastic cements by super-calcination and by incomplete calcination.* But the fact most worthy of remark is, that at the point of *complete calcination*, not only the stone does not slake, but if it be treated like ordinary cement, it gives a substance nearly inert. All this is the reverse of fat lime; and it is impossible to confound one substance with the other.

---

*The existence, at the same time, of two means of preparing plastic cement, and the obscurity in which the method of Parker remained, has occasioned more than one mis-

This instant of inertia of plastic cements, between the points of incomplete calcination and supercalcination, seems to us a capital fact in the study of the substances. It explains how a suitable lime stone might escape discovery and be rejected as unsuitable, from a simple fault of calcination, which would not be a fault with fat lime, or with hydraulic lime. In this category we may cite the trials of Gen. Treussart of the Boulogne pebbles. He calcined the stone in the middle of the common lime in an Alsace lime kiln: he was thus led to anomalies which we now easily comprehend.

*Note. The author then refers to Nos.* 1, 4, 6, 7, 9, *and* 12, *of table No. VIII, of the preceding work of Gen. Treussart. (Jour. Frank. Ins. Vol. XX, p.* 320.)

M. Vicat, effecting the calcination by the same means, no doubt, found that the cement of Baye did not harden till after three days' immersion. This would not be a long time for hydraulic lime, but it is unreasonably long for a plastic cement, which the Baye lime stone, from its composition, may be considered to be. The proportion of clay is so great in this cement, that we think it must contain a notable quantity of silex in grains; otherwise, it does not comprise a larger proportion of lime than the artificial mixtures of M. Bruyère, and like them would afford only a puzzolana and not a plastic cement.

### §14. *Experiments on the English Cement, and on the English Cement Stone.*

We will now detail the experiments that have led us to a knowledge of these alternations of good and bad quality in plastic cements—beginning with the English cement.

1st. The English stone that we had at command was of a yellowish colour, and very compact texture. After having broken it into small pieces, and placed it in a crucible, we heated it in a laboratory furnace furnished with its dome, up to the complete disengagement of the carbonic acid—as proved by pieces taken from the upper part of the crucible. But owing to the inequality of calcination in a vertical direction, a great number of fragments were found, agglutinated, fritty, and blackened. They were separated with care, and gave by trituration, a powder of blackish gray. Not knowing, at that time, the process of Parker, we thought that all the supercalcined stone must be good for nothing: and it was only to acquire a direct proof thereof that we tempered this powder with water. After a few minutes, to our surprise, the first specimen had hardened. A second specimen prepared and put under water, showed that the induration was comple in less than fifteen minutes.

take. M. Hassenfratz, for example, says in his treatise on mortars, page 195, "The calcination of this stone (Boulogne pebbles) is the same as that of ordinary lime; if it is too much heated, it vitrifies and is no longer proper for making cement." And further on (page 197) he adds, "At London they calcine, in conical furnaces with a central fire of sea coal, the lime stone of which they make Roman cement: but the management of the fire demands much attention, because when the heat is not properly adjusted, the cement sustains an incipient fusion, and is no longer proper for any use." He had, notwithstanding, said (p. 126) that the Boulogne pebbles, strongly calcined, and for a long time, gave a lime which hardens easily, and that this hardening became equal to that of stone, at least; but when it is only calcined to the same degree as fat lime, the cement does not harden with the same facility, nor so much. AUTHOR.

All the stone that was in the upper part of the crucible had escaped any sensible change of colour: pounded and sifted, it was of an earthy yellow; a mortar of stiff clayey consistence was made of it, and immediately placed under water without any envelope. It did not fall to pieces in the water, but, twenty days after, it remained in the same state, that is to say, like a substance wholly inert. A small portion of the same mortar, exposed to the air, had set in one hour and twenty-five minutes, and fifty days after had acquired great hardness.

Another portion of this same yellow powder was mixed with an equal volume of fat lime, to ascertain whether it would act like puzzolana. This mortar, examined for fifteen successive days, comported itself like the unmixed cement; but after about a month, it had set.

2d. The English cement on which we experimented was derived from a stock collected in July, 1824, for the naval works; it had therefore been on hand five years and a half. It was damaged; but we shall show further on that a very feeble heat sufficed to impart much energy to it—causing it to set in fourteen minutes. We filled a crucible with this cement and heated it: the unequal action of the heat enabled us to divide the cement into three portions, in appearance very distinct.

The first part, treated with muriatic acid, liberated no gas; a perceptible change of colour, and a slight agglutination, attested that there had been a commencement of super-calcination. A mortar was made of it, and immediately immersed: The setting was not complete till after six and a half hours.

In the next portion the beginning of super-calcination was more manifest; it should have been triturated and sifted anew, and this operation having been omitted, we think that a diminution of energy was the consequence. However this may have been, after its immersion the edges crumbled off, but the setting was complete in three hours and forty minutes.

Lastly, the third portion, which was from the bottom of the crucible, was *fritty* and *drossy;* it gave a powder of a slate blue colour. A little of it was made into mortar, and made to fill the bottom of a glass: this being put under water appeared hard in thirty-three minutes. A second larger specimen was immersed, not being supported on the sides: the edges did not crumble in the least, and at the end of forty-eight minutes it had well set.

### §15. *Similar experiments with the Pouilly Cement.*

Not having the Pouilly cement at command, we were not able to operate throughout as in the other case: but this circumstance need not, we think, be much regretted, since the cement in powder, with which we were supplied, still retained much carbonic acid, and would enable us to ascertain, equally, the effects of complete calcination and of super-calcination.

The Pouilly cement, revived by a new calcination of a few minutes, like the English cement, sets in the air in five minutes. A crucible filled with cement, already deteriorated, was calcined in a heat not very great: cement taken from the top of the crucible, had not lost its carbonic acid, and set under water in eight minutes and a half: the remainder was divided into two specimens which indurated in the air, one in eleven minutes, and the other in sixteen minutes. These cements, at the moment of setting, disengaged heat in a remarkable manner.

Another crucible filled with the same, having been heated more violently, the first portions of powder, tested by muriatic acid, retained hardly any traces of gas; they afforded a mortar, which, exposed to the air, disengaged a little heat, and hardened in thirty-six minutes. At this moment it was immersed, but soon split to pieces, softened, and preserved its consistency only in a few places. After fifty days, it was found totally reduced, and decomposed into friable lumps.

The remainder of the contents of the crucible was divided into two portions. The first, containing much that was agglutinated, required to be pulverized again; it gave a mortar that hardened in the air in twenty-one minutes, and preserved its form, well, after immersion. The second, completely converted into scoria, became, in powder, of a blue purple: converted into mortar, it hardened in the air in twenty-six minutes, and did not lose its consistency in water.

### §16. *Indications, touching the preceding experiments, given by the proof of Rupture.*

It became interesting to complete these experiments, trying the proof, or test, of rupture; and such is the object of the following table: but we have some previous observations to make.

Plastic cements acquire a strong consistence in a short time. For example, the experiments of M. Leroux at Cherbourg, reported in the memoir of M. Mallet already quoted, were made after about fifty days, and gave very satisfactory results. We have operated with a shorter interval: but it is possible that two mortars may be equal at the end of the year, and not at any briefer period, especially when one is immersed, the other exposed to the air, and when the volumes are very small. But we could not avoid this last inconvenience, because, from being obliged to separate the products into several portions, the bulk of each particular kind was necessarily small. For each specimen we never had more than fifteen cubic inches of mortar: the numbers that we are to submit must therefore be received with caution, and only as stating the hydraulic qualities of the substances.

Table No. XLIX.

| No. | Substances employed. | Time required to harden. | Resistance to rupture per 0.394 inch (centimetre) square. | Age of the mortars. | Observations. |
|---|---|---|---|---|---|
| | | | lbs. | Days. | |
| 1 | English stone completely decarbonated . . | | | 20 | Could not be tested. |
| 2 | The same stone, with fat lime | | 1.10 | 50 | Immersed. |
| 3 | The same, super-calcined | 15′ in water. | 6.39 | 50 | Do. |
| 4 | English stone, carbonated | 14′ in the air. | 15.75 | 35 | Exposed to the air. |
| 5 | The same . . . | 14′ in water. | 7.24 | 35 | Immersed. |
| 6 | The same reburnt up to super-calcination . . | 6 h.and 30′ | | | Put in a glass. |
| 7 | The same, super-calcinated more strongly . . . | 3 h. and 40′ | 2.69 | 35 | Immersed. |
| 8 | The same, super-calcinated to the state of scoriæ . | 48′ | 5.17 | 36 | Do. |
| 9 | Pouilly cement carbonated | 5′ in the air. | 3.46 | 34 | Do. |
| 10 | Do. . . . | 16′ | 1.93 | 34 | Do. |
| 11 | Do. . . | 11′ | 4.22 | 34 | Do. |
| 12 | The same, completely decarbonated . . . | 36′ in the air. | | 30 | Fell to pieces under water. |
| 13 | The same, perceptibly fritty | 21 in water. | 19.07 | 34 | Immersed. |
| 14 | The same, in scoriæ . | 26' | 3.15 | 34 | Do. |

### §17. *On the alteration of Plastic Cements.*

The English cement delivered at the Port of Brest, in 1824, was preserved in well closed barrels: that which came to us from Pouilly was in a double cask, with an interval of about two inches filled with absorbent powder of common lime or powdered charcoal: this last method is very expensive no doubt, but it is preferable to the first, when the cement is to remain a long time in store. Whatever may be the process, however, the substance, whether it retains a portion of carbonic acid, or has been super-calcinated, will always lose part of its energy.

In fact, the English cement, which in the first place, set under water in twenty-two minutes, required twenty-one hours to set, after it was five years old, without the barrels having been opened or exposed in any humid place. The Pouilly cement which may be made so energetic as to harden in the air in five minutes, required forty-eight minutes as a mean term of the several trials to which we submitted it, after being four months in store. Further, the barrel having been first opened, and then closed less exactly, sufficed to cause the outside layers of cement to afford a mortar the edges of which crumbled under water, and which had not hardened at the end of four hours.

As to the super-calcined cement, that which would harden, in the first instance, in fifteen minutes, was so altered by thirty-nine days' exposure to the air, that it had acquired only a half-consistence during three days that we successively examined it.

Under such circumstances, we may easily see that the mortars are not susceptible of acquiring great hardness. It is true that the diminution in this respect, is not proportioned to the diminution in the energy of setting; but it does not the less follow, that those plastic cements of which the use is deferred, lose the quality the most characteristic, if not the most precious; and that notwithstanding the precaution used in barreling the substance, the evil can only be retarded. Connected with this, if we consider the liability to negligence in the process of calcination and pulverization, we can comprehend how it is that the use of plastic cements has fallen more than once into disfavor; why the manufacturers have been accused of mixing inert matter with their products in order to augment the bulk; and why the great price of these substances, joined to the uncertainty as to their qualities, has deterred many constructors from their use.

### §18. *On the chemical phenomenon that accompany the alteration of Plastic Cements.*

We were at first of opinion, from such considerations as are above stated, that it would be preferable to export, instead of the cement, the cement stone before calcination, as is done with plaster of Paris. An augmentation of weight of twenty or thirty per cent. might be compensated by the suppression of the barreling and all other means of preservation. But although we might act thus in certain places, we could not in all places: and there would be no guarantee that the best mode of preparation would be followed every where; or that the quantity of cement needed, would be worth the trouble of calcination.

Examining then, what occurs in the alteration of plastic cements, we in the first place, ascertained that the super-calcined cement, when exposed to the air for thirty-nine days, had absorbed carbonic acid, and we concluded, *a fortiori*, it would be the same with the cement incompletely calcined, because the combination of lime and clay does not, therein, take so much cohesion; but we have not been able to satisfy ourselves that this gas, often found in cement the quality of which is good, should be hurtful when found under other circumstances; we have considered, as much more probable, that its presence is indifferent in all cases; and that the cements were good only because the lime and the elements of the clay existed therein in a proper state of combination.

We ascertained, afterward, that cements, while they enjoy all their energy, are not soluble in water; or at least the oxalate of ammonia gives to the water in which they have been immersed, scarcely the lightest cloud. The deteriorated cements, on the contrary, give a precipitate quite abundant, and susceptible of being collected.

We noticed, lastly, that the super-calcined cement and the Pouilly cement, which are of a deep colour, become whiter as they deteriorate; and the white parts give to the water in which they are immersed, a cream which is incapable of solidifying.

From these indications we have concluded that the deterioration of cements is accompanied by a chemical disunion between the lime and the clay composing them; that no doubt the lapse of time between the preparation and the use of the cement, may permit a spontaneous decomposition, but that water, either alone or aided by carbonic acid, is the most active cause; and that we may, therefore, restore to these elements all their primitive energy, by submitting them to a new calcination sufficient to drive off the absorbed water, and re-establish the combination between the lime and the clay.

These are the theoretic inductions which determined our researches as to the possibility of making use of damaged cements. Experience has fully confirmed them, as will be seen in due time.

### §19. *On the revivification of deteriorated cements.*

Pouilly cement that hardened in the air in twenty three minutes was heated to a low red heat during twenty five minutes, on a plate of iron. After this operation, being tested with muriatic acid, it showed the presence of carbonic acid, as before: converted into mortar it became hot and solidified almost instantly. The setting was perfect in less than five minutes.

Cement of the same kind, heated more violently, and in a crucible, was divided into three portions: the first hardened under water in eight and a half minutes, the second in the air in sixteen minutes, and the third, in eleven minutes. All three, tried by muriatic acid, disengaged much carbonic acid.

English cement, setting under water in twenty one hours, was made red hot on a plate of iron for twenty eight minutes: this operation did not deprive it of its carbonic acid: tempered and immersed, it hardened in thirty-one minutes.

Cement of the same kind heated for about one hour was divided into two parts: the first, retaining still a little carbonic acid, hardened in the air in fourteen minutes, and the second, which was nearly in the same state, hardened under water in fourteen minutes.

English cement supercalcined, exposed to the air during thirty nine days, and which had become incapable of setting under water in two days, was heated on a piece of sheet iron to a red heat for thirty minutes. It retained all the carbonic acid it had absorbed: being tempered and immersed it set completely in thirty-one minutes.

Wishing to apply this operation on a large scale we exposed entire barrels of the deteriorated cement in the reverberatory furnace, in the same way we had exposed the gneiss sand. After this new torrefaction, the English cement which had refused to indurate in less than twenty-one hours, would now set equally hard in twenty-three minutes, at most, either in the air or in the water. In similar circumstances the Pouilly cement which did not harden in less than two or three hours, was brought to give very good results in seven or eight minutes.

There is no doubt then, that at a small expense, and by the aid of a feeble heat, the injury sustained by plastic cements, from remaining too long in store rooms, or exposed in damp places, may be repaired.

### §20. *On the recovery of cement mortars already hardened.*

The experiments we have just given caused us to conceive the hope of restoring cements which had hardened after being accidentally moistened and even of restoring mortars themselves. We ascertained that the thing is, in fact possible, but at a much higher temperature.

Mortar made of Pouilly cement, one month old, and already offering a resistance to rupture of about 13 lbs. per 0.394 inch (centimetre) square, was reduced to powder. A portion of this powder made red hot for twenty minutes, gave a mortar which did not become hot and did not harden. Another portion was heated in a crucible for almost one hour: the first layers of cement had visibly changed colour, but had not lost their carbonic acid: they gave a mortar that acted like inert matter. The last layers, on the contrary, were completely decarbonated; a mortar was made of this which increased in temperature sensibly after three minutes' exposure to the air, and hardened after ten minutes; but being then immersed, it split and softened.

Some of the same powder heated more highly in a crucible, and giving some indication of supercalcination, was tempered with water, but, from inadvertency, into too soft a paste. The setting was nevertheless complete after four hours in the air, and it sustained itself well in the water.

Another crucible heated more highly still, gave a mortar which, exposed in the air, took immediately a remarkable consistency; at the end of six minutes, the trial wire gave almost no depression on the surface. There was no heat disengaged at the time of setting.

A last crucible, heated in the same manner, gave also a supercalcined cement which hardened in eight minutes without any disengagement of heat. This specimen and the preceding were immersed immediately; the water did not alter them.

If it be desired to reproduce these results on a large scale, it must not be done in a kiln built to burn puzzolanas, but in a lime kiln; taking care to place the mortar or blocks of hardened cement at the bottom of the charge, in order to obtain the proper degree of supercalcination. We should add, however, that we have not employed this mode of restoration.

### §21. *Indications touching the preceding experiments, given by the proof of rupture.*

As in §16, we have united, in the following table, the resistances to rupture of the specimens of mortar of which we have been speaking in the preceding paragraphs.

Table L.

| No. | Substances employed. | Time required to harden. | Resistance to rupture per 0.394 in. (centimetre) square. | Age of the mortar. | Remarks. |
|---|---|---|---|---|---|
| | | | lbs. | ds. | |
| 1 | Pouilly cement . | 23′ in the air | 20.25 | 35 | Left in the air. |
| 2 | do. restored on a plate of sheet iron . | 5′ | 3.46 | 34 | Immersed. |
| 3 | do. do. in a crucible | 11′ | 4.23 | 34 | do. |
| 4 | do. do. by supercalcination . | 5′ | 11.53 | 26 | Left in the air. |
| 5 | English cement deteriorated | 21 hours | 3.27 | 35 | Immersed. |
| 6 | do. restored on a plate of sheet iron . | 31′ | 4.32 | 35 | do. |
| 7 | do. do. in a crucible . . | 14′ in the air | 15.75 | 35 | Left in the air. |
| 8 | do. . . | 14′ in the water | 7.22 | 35 | Immersed. |
| 9 | Mortar restored by supercalcination . | 4 hours | 3.60 | 26 | do. |
| 10 | do. more highly calcined | 6′ in the air | 4.26 | 26 | do. |
| 11 | do. . . | 8′ | 15.26 | 26 | Left in the air. |

### §22. *Influence of the age of Mortars.*

The two tables we have given of experiments, show a notable difference between mortar immersed and mortar exposed to the air—unfavourable to the former in all cases but No. 13 of the first table. They also show differences between the specimens immersed, which, judging from the time required to harden, were equal in quality. Has the age of the mortar an influence on these results? This we were desirous of ascertaining, at least in part, by some trials which are given in the following table.

Table LI.

| No. | Substances employed. | Time required to harden. | Age of the mortar at the first trial. | Resistance to rupture per 0.394 inch (centimetre) square. | Age of the mortar at the second trial. | | Resistance to rupture per 0.394 inch (centimetre) square. |
|---|---|---|---|---|---|---|---|
| | | | ds. | lbs. | mos. | ds. | lbs. |
| 1 | Pouilly cement with one half volume of water. . . | 46′ | 22 | 7.35 | 1 | 19 | 8.01 |
| 2 | do. . | 46 | 27 | 9.72 | 4 | 11 | 14.36 |
| 3 | do. . . | 51 | 34 | 17.70 | 1 | 19 | 16.92 |
| 4 | do. . | 42 | 42 | 14.64 | 4 | 11 | 14.71 |
| 5 | do. . . | 52 | 49 | 13.03 | 4 | 11 | 24.11 |
| 6 | do. . | 54 | 51 | 15.29 | 4 | 11 | 19.59 |
| 7 | do. . . | 47 | 60 | 19.11 | 4 | 11 | 19.76 |

All these specimens were made, the same day, with cement from the same barrel, tempered with an equal quantity of water, and immersed immediately after the instant of setting in the air; they were all of the size of a common brick. Notwithstanding these similar circumstances, the mortars did not comport in the same manner; and they converged more or less rapidly to the resistance they would have acquired at some future period, as, for example, at the end of one or two years.

### §23. *On the mixture of sand and puzzolana with plastic cements.*

Thus far we have employed pure cement, in order to avoid bringing in new cases of irregularity; but it is not less necessary to know to what extent the substances will support a mixture of sands or puzzolanas: and consequently, to know whether it be possible so to add these substances as to have mortars equally good and more economical. With these objects we prepared several specimens which were submitted to rupture after about fifty-four days. This, as has been said above, is no doubt too short a time: but the numbers obtained agree in demonstrating that though sands and puzzolanas, in no way augment the quality of cement-mortars, they may be used without detriment in small proportion; as may be judged by the following table.

Table LII.

| Substances employed. | | Time required to harden | Age of the mortar at time of trial | Resistances to rupture. |
|---|---|---|---|---|
| | | min. | days. | lbs. |
| One of Pouilly cement with | one-half of quartzose sand | 48 | 54 | 14.64 |
| do. | one-half of gneiss sand | 43 | do. | 17.57 |
| do. | one-half of coarse quartzose sand . | 50 | do. | 12.31 |
| do. | one-half of Italian puzzolana in gravel . | 58 | do. | 14.55 |
| do. | one-half of quartzose sand | 44 | do. | 11.35 |
| do. | one-half of do. and one-half of puzzolana. . | 57 | do. | 13.04 |
| do. | one of gneiss sand . | 47 | do. | 13.58 |
| do. | one of coarse quartzose sand . | 1 h. 2m | do. | 9.89 |
| do. | one of puzzolana sifted very fine . . | 49 | do. | 14.74 |
| do. | one and a half of quartzose sand . | 47 | do. | 8.29 |
| do. | one and a half of gneiss sand . . | 1h. 7m. | do. | 7.61 |
| do. | two of quartzose sand | 1h. 18m. | do. | 5.86 |

As to the ability of these cements to resist frost we have no precise information to impart. We can only say that we applied the process of Mr. Biard to a specimen of pure Pouilly cement which had hardened in the air and was five months old. It deteriorated sensibly from the beginning of the experiment; and at the end of the seventh day we found 1.43 gr. loss from the original weight of 210 grs. Several kinds of bricks tried at the same time, as well as a specimen of mortar made of puzzolana from Italy, did not lose, by a great deal, as large a proportion of their substance. It is to be feared, therefore, that mortar of the Pouilly cement is not frost proof: and this will become a great objection, if, as has been proposed, this cement is used in making casts of moulded objects, statues, bas-reliefs, vases, &c., to be exposed to the ordinary inclemencies of the weather.

### §24. *Classification of plastic cements with respect to limes and to puzzolanas.*

As we said in the beginning of this article, the limestones that afford plastic-cements contain a large proportion of clay: larger than hydraulic limestones, and less than calcareous puzzolanas. Establishing then the continued series of combinations which may be formed of pure lime and pure clay, we shall be led, as in the following classification, to three distinct products.

Table LIII.

| Lime. | Clay. | Resulting products. | Distinctive characters of the products. |
|---|---|---|---|
| 100 | 0 | Very fat lime | Incapable of hardening in water. |
| 90 | 10 | Lime a little hydraulic | Will slake, when properly calcined, like pure lime—and will besides harden alone under water. |
| 80 | 20 | do. quite hydraulic | |
| 70 | 30 | do. do. | |
| 60 | 40 | Plastic cement | Will not slake with any degree of calcination—and will harden alone under water. |
| 50 | 50 | do. | |
| 40 | 60 | do. | |
| 30 | 70 | Calcareous puzzolana according to Mr. Bruyére | Will not harden under water without the addition of fat lime or of hydraulic lime. |
| 20 | 80 | do. | |
| 10 | 90 | do. | |
| 0 | 100 | Puzzolana of pure clay | The same. |

The distinctive characters given in the table, show, as the proportions vary, the effects of a predominance of lime or clay. But the plastic cements have two maxima of energy, one at the point of incomplete calcination, and the other at the point of supercalcination: do they enjoy this singular property, exclusively? It is important to ascertain this.

1st. Pure lime stone incompletely calcined, slakes with difficulty, and even requires to be pulverised like plastic cement. According to Mr. Minard, if it be tempered with water and immersed, it comports in the beginning like a very energetic substance; and after four days, according to Mr. Vicat, it is impossible to make an impression with the finger. But beyond this, the solidification does not advance.

On the other hand Hassenfratz (at page 203 of his *Traité des mortiers*) says he has noticed that the fat lime of Moustier, supercalcined, gives, after being pulverised and tempered, a mortar which *sets strongly in water.* Mr. Vicat, also, announced in 1818 that common fat lime supercalcined, in contact with a mixture of charcoal and seacoal, became incapable of slaking, and gave, on pulverizing and moistening it, *a paste which hardened under water.*

It is hardly necessary to say that at the term of complete calcination, fat limes are entirely incapable of acquiring, alone, under water, any consistency. However feeble, therefore, may be the hydraulic property of fat lime at the points of incomplete and supercalcination, it is not the less true that it does exist, as in plastic cements.

2nd. Before Mr. Lacordaire had engaged in the Pouilly enterprise described §12, he had ascertained that a limestone but little hydraulic, from which all the carbonic acid had not been expelled by calcination, afforded a true cement; and he applied this observation to profit, in the works of the canal *de Bourgogne,* which he had in charge. With this view he used the ordinary kilns of the country, reducing to three days, the burning which was commonly extended to six or eight days: he afterwards slaked the lime by immersion, separating the subcarbonated portions, which he incorporated in the mortar, after having reduced them mechanically to powder.

We were of opinion that the common limestone of Pouilly, alternating with the variegated marles, contained, like the marles, the claystone (septaria) of which Parker's cement is made, and that if Mr. Lacordaire preferred extracting these materials by subterranean galleries, rather than by open quarries, it was, no doubt, because he found, below, richer deposits and a better choice of materials. But one of our friends, Mr. Avril, an Engineer, to whom we had communicated our researches, profited by his being at Pouilly to examine this point with much care. He has announced that, in fact, the common limestone of Pouilly properly treated, and retaining about fifteen per cent. of carbonic acid, sets under water in five minutes, and does not yield in any thing to plastic cements; that therefore, the preference accorded to septaria, could not be explained except on the supposition that it was easier, with it, to secure the degree of calcination necessary, and because the limits of greatest energy were more extended. He also discovered that the hydraulic limestone of Pouilly, *suitably supercalcined*, enjoyed the same properties as when in the state of subcarbonate.

Some direct experiments on a few fragments of a hydraulic lime stone from Pompean, *(Ille-et-Vilaine,)* and from Doué *(Maine-et-Loire,)* lead us to believe that these properties are common to all limestones of analogous composition.

3rd. The good puzzolanas produced, on the one hand, by a torrefaction of some minutes on plates of iron, and on the other, by ochreous and refractory bricks, well burned, seem at first to establish two maxima of energy for clays also; but the experiments of the 17th article, (§6 and §7) demonstrated that these two degrees of heat are in fact but one and the same, and that these substances become so much the more inert as the term, of vitrification is approached.

As to clays containing at least a tenth of lime, they require, according to M. Treussart, that the degree of calcination should correspond with that of a slightly burned brick; beyond which they become of a quality more and more deteriorated. Is it still the same, at the transition from puzzolanas to plastic cements, when the proportion of lime is from twenty to thirty per cent.? We are unable to say. But it is possible that the influence of lime is then prominent enough to give rise to two maxima of energy.

### §25. *Geometrical representation of the influence of Heat on the several compounds of Lime and Clay.*

In order the better to exhibit the influence of heat on the several compounds of clay and lime, we will attempt to represent it geometrically. To do so, let us conceive that from a fixed point two lines are drawn at right angles to each other, of which the horizontal one shall be taken as the axis of the abscissas, and the vertical one, the axis of the ordinates. Then suppose that on the axis of the abscissas we take, from the point of intersection, lengths proportionate to some of the principal degrees of torrefaction; that, for example, we choose for the first the degree of moderate burning of bricks; for the second, the degree of thorough burning of bricks; for the third, the degree of complete calcination of fat lime; and lastly, for the fourth, the degree of super-calcination of the same lime. If, then, the ordinates be raised on the points of division, and we consider the compounds of lime and clay to be submitted to the corresponding degrees of heat, we might lay off on these ordinates, lengths proportionate to the hydraulic energy of each particular product; and afterward, through the extremities of these lengths, pass a continuous curve, which will be the curve of energy of the compound, whether hydraulic lime, plastic cement, puzzolana, or even fat lime.

In this manner we have constructed the figures 4, 5, 6, 7 and 8, of plate II. Let us go into some particulars respecting them.

1st. Fig. 4 represents the curve of energy of fat lime. This curve has one ordinate null at the abscissa No. 3, which is the term of complete calcination; but at the abscissas 2 and 4, the ordinates have some magnitude, for they correspond to a hydraulic power, feeble it is true, but real.

2d. Fig. 5 represents the curve of energy of hydraulic lime. At the abscissa No. 3, the ordinate will vary much according to the portion of clay contained; but is greater than zero and less than the ordinates Nos. 2 and 4, because on one hand the lime is hydraulic by supposition, and on the other hand we obtain an instantaneous induration, and an improvement in the hardness of mortars, as in plastic cements.

3d. Fig. 6 represents the curve of energy of plastic cements. In some the ordinate No. 3 is nearly null: is it the same in all? we think not. We know in fact that the best hydraulic limes are not those which contain the most clay; that, for example, in the manufacture of artificial hydraulic lime, the proportions of twenty to twenty-five per cent. of clay are recommended as being most suitable. Accordingly, the ordinate No. 3, which is null for fat limes, will augment progressively up to lime containing twenty-five per cent. of clay, then descending in a continuous manner for the limes with thirty per cent. of clay, for the plastic cements with forty, fifty and sixty per cent., finishing by becoming null. We give this explanation as a simple theoretical induction only.

4th. Fig. 7 represents the curve of energy of calcareous clays employed as puzzolanas. The maximum of this curve is at the abscissa No. 1—the term of bricks but little burned. The clays which, from the proportion of lime, approach most nearly to plastic cement, enjoy, perhaps, a second maximum of energy: but we have traced it only by a dotted line.

5th. Fig. 8 represents the curve of energy of clays not calcareous. This curve has only one maximum, which is at No. 2—the term of bricks well burned.

To resume—we see that each of the compounds of lime and clay is characterised by certain properties which vary, more or less, according to the predominance of one or the other of these constituents; that clays have only one maximum of energy, but that limes have two, and that, therefore, plastic cements only offer a particular case of a general phenomenon.

## ARTICLE XIX.—*On the change in Hydraulic Limes, and on the solidification of Mortars in general.*

### §26. *Influence of spontaneous slaking on Lime in general.*

As lime is not always used immediately on leaving the kiln, it is important to know what modifications time will bring about in its proper-

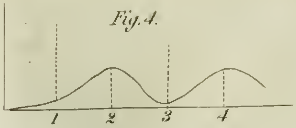


Fig. 4.

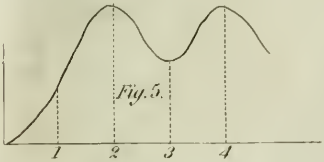


Fig. 5.

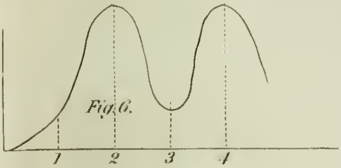


Fig. 6.

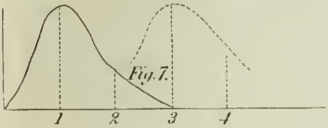


Fig. 7.

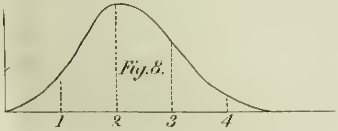


Fig. 8.

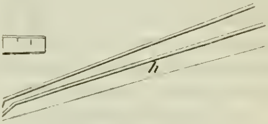


Fig. 4.

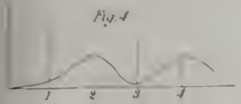


Fig. 5.

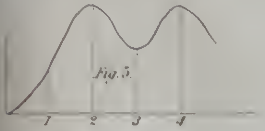


Fig. 6.

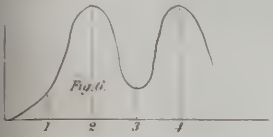


Fig. 7.

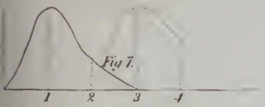


Fig. 8.

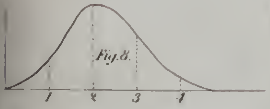


Fig. 9.

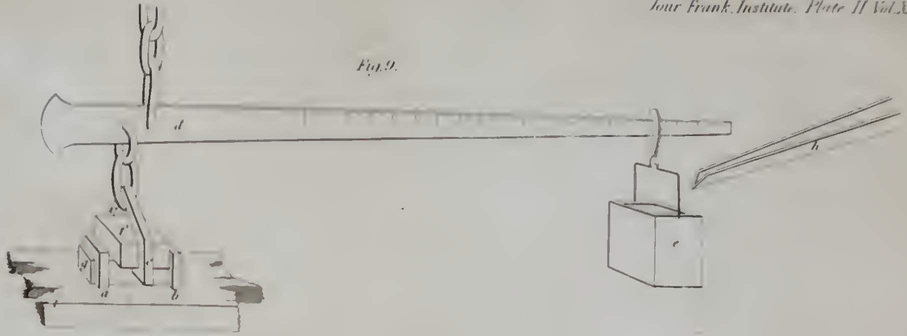
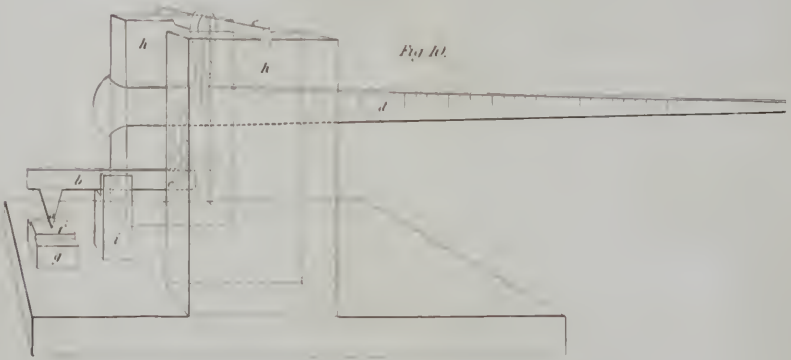


Fig. 10.



ties; and what precautions are necessary for its preservation, or in its use, after it may have become deteriorated.

When quick lime is abandoned to the contact of air, it absorbs moisture and carbonic acid from the atmosphere, and a certain quantity of oxygen also, according to Gen. Treussart. At the same time it splits and falls to powder; this being what is called *spontaneous slaking*, or *air slaking*.

For a long time it was thought that lime thus slaked was good for nothing; but this was improperly generalizing a consequence which is true only with one particular kind of lime. In fact, M. Vicat has ascertained, 1st, that fat limes do not deteriorate, and that they even give superior results to those obtained by slaking in the ordinary mode of immersion: 2d, that for hydraulic limes, on the contrary, spontaneous slaking is the more disadvantageous as the energy of the lime is originally the greater.

We owe to Gen. Treussart the proof of this last observation; obtained while he was in search of the relation between the degrees of alteration in the air; and time of exposure to the air. The following are some of his results.

Table No. LIV.

| | Made immediately. | After 15 days. | After 1 month. | After 2 months. | After 3 months. |
|---|---|---|---|---|---|
| | lbs. | lbs. | lbs. | lbs. | lbs. |
| Obernai hydraulic lime with two parts of sand | 121 | 77 | 44 | 33 | 22 |

These specimens were all kept under water. We see, therefore, that all delay in the use of hydraulic lime tends to convert it into common lime, and that in large works a circumstance of this kind might be of serious consequence.

### § 27. *On the manner of preserving Hydraulic Limes.*

In the deterioration of hydraulic limes it is necessary to consider the influence of the water applied in slaking, and the influence of the contact of air. While the quantity of water absorbed does not exceed a quarter of the weight of lime, this last will remain in dry powder; it cannot solidify; and experience demonstrates that it may then be preserved without change, provided it be carefully covered from the contact of the air, in very tight barrels for example, like plastic cement. But if this powder, which is easily obtained by immersing the lime for twenty or thirty seconds in water, is exposed to the air, it comports nearly as in the case of air slaking; it becomes common lime. At works where there must be large supplies, it is hardly possible, however, to put the lime in casks, because they would be expensive from their number, and embarrassing from their bulk. A middle course remains, which consists in storing the quick lime in very close sheds, and enveloping it, on all sides, with a layer of lime already reduced to powder, in any way: an obstacle will thus be opposed to the circulation of air, and the interior parts of the mass will be preserved from its influence.

If this process is not perfect, it is at least economical: and although all the layers of powder which serve as an envelope will be unfit to be used as hydraulic lime, it still may be used in a way that will soon be pointed out.

### § 28. *On the use of Puzzolanas in correcting the deterioration of Hydraulic Lime.*

In order to cause fat lime to harden under water, it is mixed with puzzolana; but deteriorated hydraulic limes, as we have said, act like fat lime: if this assimilation be exact, then the same process ought to be applied to both. This is, in fact, what happens; and it is observed that the amount of alteration has no sensible influence on the hardness acquired after about one year. Gen. Treussart was the first who insisted on this important fact; the following are some of his experiments.

Table No. LV.

| | Made immediately. | After 1 month. | After 2 months. | After 3 months. | After 4 months. |
|---|---|---|---|---|---|
| | lbs. | lbs. | lbs. | lbs. | lbs. |
| Obernai hydraulic lime slaked spontaneously and mixed with one of sand and one of trass . . . . | 209 | 389 | 352 | 308 | 495 |

Table No. LVI.

| | Made immediately. | After 15 days. | After 25 days. | After 35 days. | After 45 days. | After 2 months |
|---|---|---|---|---|---|---|
| | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| Obernai hydraulic lime slaked by immersion and mixed with one of sand and one of trass . . . | 493 | 330 | 297 | 286 | 304 | 399 |

Hydraulic limes employed while fresh, will, according to M. Vicat, support puzzolanas the more advantageously, as the limes are the less energetic; and on the other hand, they deteriorate so much the more rapidly as they are the more energetic: we may thence conclude that if a hydraulic lime has been exposed to any cause of deterioration, it is prudent to mix with it, a certain dose of puzzolana, without any regard to its primitive degree of energy. Artificial hydraulic limes should be treated in the same way.

### § 29. *On the preservation of Puzzolanas.*

As to factitious puzzolanas, it may readily be conceived that their preservation requires but little care, for we know that from their situation in nature, the natural puzzolanas are exposed to all the vicissitudes of the seasons without any apparent loss of energy after a great lapse of time. We will say, however, that a newly made and perfectly dry puzzolana, from its possessing a higher degree of absorbent power, must have a favourable influence on the setting of the mortars. The mortars are often, in fact, tempered too soft; and, to lime already slaked to cream, the workmen add more water to lessen their labour; this excess of water being absorbed in part by the puzzolana, the mortar preserves a strong consistence, favourable to the reaction of its elements. In this respect it is therefore advantageous to keep the puzzolanas in dry situations, or at least if they have been moistened, to dry them in the air, or in the sun, before using them.

### § 30. *On the Solidification of Fat Lime.*

The preparation and the preservation of lime, puzzolana, and plastic cements, are connected so intimately with a knowledge of their properties, that we think it will be useful to add to the indications already given, some developments relative to the theory of mortars in general.*

Proceeding from the simple to the compound, let us explain what relates to common, or fat, lime. When it is plunged into water, it absorbs rapidly, and solidifies, a quantity of water equal nearly to 0.22 of its weight. Withdrawn, then, and left in contact with the air, it slakes with disengagement of heat, and is reduced to dry and impalpable powder. In this state it is capable of absorbing much water still, but without sensible disengagement of heat, and there results a paste more or less stiff. The first portions of the fluid, form, with the lime, a true chemical combination, known by the name of *hydrate of lime:* the other portions of water are, simply, *interposed.* Thus, lime in stiff paste will throw out, on working it, so much water that it is unnecessary to add more on making the mortar. The hydrate of lime, on the other hand, can only be decomposed at a high temperature.

This hydrate being a dry powder, its molecules are too far apart to be able mutually to approach each other, and to pass into the state of a compact mass; it is only after being brought to the state of paste that the hydrate is in a condition to be used. That being premised, it is well known that fat lime, if kept from contact with the air, may be preserved an indefinite time in paste; that this same lime at the ordinary temperature, or at a higher temperature, in paste, or dissolved in water, is without any chemical action on quartzose sand, whether the sand be in fine powder or not; that the mortars which result from the mixture of these two substances, remain soft, like lime alone, as has been ascertained by Dr. John, on examining thick masonry two hundred years old. But if the lime in paste, or the mortar, be left in contact with the air, it will solidify; and if the air be replaced by pure carbonic acid gas, the solidification will take place with great rapidity. In both these last cases the carbonic acid is absorbed by the lime, and this absorption will go on till the acid is to the base, in the ratio, approximately, of 43 to 57, as in the natural subcarbonate of lime. But it is worthy of remark that the proportion of water appropriated to the conversion of lime into a hydrate, is not rejected: the carbonate is not, therefore, *regenerated,* as before the calcination; and it is, in fact, a double salt, which might be called the *hydro-carbonate* of lime.

We see then that for the solidification of fat lime, 1st, the proportion of water must be greater than in the dry hydrate: 2d, there should be contact of the air, or, better still, of pure carbonic acid gas. 3d, the mixture of quartzose sand, without the contact of the air, would not have the least influence. Hence comes the superiority that lime slaked spontaneously, and consequently already somewhat carbonated, imparts to mortars. Hence also the impossibility that these mortars should harden under water, since water, in general, contains only inappreciable quantities of carbonic acid in solution.

The solidification, as Mr. Vicat remarks, spreads from the surface to-

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*In a manuscript note communicated to M. Vicat early in 1826, and mentioned in his last work on mortars, we have already stated some of the propositions which follow.
AUTHOR.

wards the centre of the specimen: but the quantity of gas that can pass through the voids of mortar beyond a short distance, is too small for its direct influence to be sensible: if then, there is not a total cessation of absorption, it must be admitted that the transmission must go on by the play of affinities—by the tendency that the several concentric layers of lime have to an equilibrium of saturation, like the transmission of heat in solid bodies. It must also be admitted that the equilibrium is the more difficult to attain, as the parts requiring saturation are more remote from the surface, and the dose of acid already received, is the greater, so that the thickness of mortars is injurious to their solidification: that in equal times, the increase in hardness will be far from being equal, and will progressively become less and less, and, lastly, though it may be exact to say that mortars made of fat lime improve as they grow old, still the improvement may not be at all sensible at the expiration of periods of only a few years each.

### § 31. *On the distinctive characters of Meagre lime and Hydraulic lime.*

Natural limestones often contain earthy or metallic oxides, which by calcination combine with the lime. Whence result modifications in its properties. Thus it is known that lime will remain a fat lime so long as the foreign substances do not form a tenth of its weight; but beyond that it becomes meagre, that is to say, it swells much less on slaking; and, if amongst these foreign bodies, silex should predominate, the paste, with, or without, sand, will acquire the property of hardening in water. It was for a long time thought that other foreign bodies acted like silex; but the method of investigation followed by Mr. Berthier, leaves no doubt in this respect. We will give a summary of his results.

Comparing, first, the quality of various limes with their chemical composition, Mr. Berthier found:

*Fat lime* from Chateau-Landon to contain 96.4 pure lime—1.80 of magnesia—1.80 of clay (silex and alumine.)

*Meagre lime* from Coulommiers 78.00 pure lime—20.00 of magnesia—2.00 of clay (silex and alumine.)

*Lime moderately hydraulic* from Saint-Germain—89.00 of pure lime—1.00 of magnesia—10.00 of clay (silex and alumine.)

*Lime very hydraulic* from Senonches—70.00 of pure lime—1.00 of magnesia—29.00 of silex. To these analyses we will add:

*Meagre lime* of Brest—82.30 of lime—10.00 of oxide of iron—7.70 of clay.

We see from these analyses that silex, whether pure or mixed with alumine, renders lime hydraulic; and that magnesia, or the oxide of iron, renders it meagre and not hydraulic. Mr. Berthier found the same consequences when proceeding synthetically: he ascertained that silex in jelly, calcined with pure lime, gave an hydraulic product; that alumine, magnesia, oxide of iron, and oxide of manganese, calcined, one by one, with pure lime, gave a meagre lime only: that alumine or magnesia mixed with silex increased the hydraulic property, and, lastly, that the proportions the most favourable for the mixture were equal parts of silex on the one hand and alumine or magnesia on the other.

A consequence results from these considerations which it is important to mention: it is this, that the process of Mr. Vicat for preparing artificial hydraulic lime, does not answer equally well on taking any limestone or clay that may present itself: that it is, with difficulty, applicable to meagre limes mixed with ochreous clays, and that this is the case at Brest, where, the matters being charged with oxide of iron, nothing passable was obtained, and we were obliged to resort to puzzolanas.

### § 32. *On the solidification of hydraulic lime.*

Hydraulic lime slaked in the ordinary manner solidifies a certain quantity of water as fat lime does; and forms, with an excess of water, a paste, more or less stiff. If left exposed to the air, it absorbs less carbonic acid than fat lime; and, like fat lime, it retains the water it had solidified.

According to Mr. Vicat there are in 100 parts of fat lime = 100.00

| | |
|---|---|
| Absorbed carbonic acid | 76.00 |
| Retained water | 17.00 |

And in 100 parts of hydraulic lime which contains a fifth of its weight of clay:

| | |
|---|---|
| Absorbed carbonic acid | 54.00 |
| Retained water | 15.00 |

But this last result may be put under the following form:

| | |
|---|---|
| Pure lime | 100.00 |
| Clay | 25.00 |
| Carbonic acid | 67.50 |
| Water | 18.70 |

It differs therefore, in this respect, very little from fat lime, so that it is equally a *hydro-carbonate* of lime, the clay appearing not to enter into the combination.

On the other hand, when the paste remains immersed in water, the aid of the carbonic acid is no longer possible, and that of the silex becomes indispensible to solidification. It remains to seek the cause of this phenomenon.

1st. Pure lime is soluble in five or six hundred times its weight of water, and the product is called *lime water.*

2nd. Pure lime combined by calcination with gelatinous silex is only partially soluble in water, and leaves a residue, composed of sixty-five parts of silex and thirty-five parts of lime, which is known under the name of *neutral silicate of lime.*

3rd. Pure lime combined in the same manner with alumine, magnesia, oxide of iron, or oxide of manganese, although it has lost the property of swelling much, or slaking, is still soluble in water, and the residue contains nothing but pure alumine, or magnesia, or the oxide of iron or manganese.

4th. In order that a lime may be hydraulic, it will suffice that it possesses six or seven per cent. of silex, a quantity that can render only a very small dose of lime insoluble.

5th. Plastic cements, at the point of complete calcination, may be assimilated to ordinary lime—they are but slightly hydraulic, although they contain a considerable portion of silex.

We see then that the combination of silex with lime has, alone, the advantage of resisting the attacks of water: that if alumine and some other oxides raise the hydraulic energies, it arises probably from this, that the obstacle they interpose to the swelling of the lime tends to the concentration of the molecules, thereby helping their predisposition to submit to the influence of the silicate of lime: and that free lime, notwithstanding its solubility, ought always to predominate in the immersed paste.

The question being thus stated, it is necessary to explain two effects; the insolubility, and the hardness, acquired by mortars under water.

In the first place, it cannot be admitted that the silicate of lime solidifies separately, and that it envelopes the hydrate as a gangue; for the last would not be less soluble, and the hardness acquired would be proportionate to the quantity of silicate, which, in general, is not true. Every thing leads to the opinion rather, that the molecules of silicate are so many centres of attraction, with respect to the soluble molecules, and that, within the sphere of activity of each of these centres, there is an arrangement which may be assimilated to a true *crystallization.*

On this hypothesis, we conceive, the most proper proportion of silicate, is that which leaves around each molecule thereof, a layer of hydrate equal in thickness to the radius of the sphere of attraction: that below this term, that is to say, in measure as the silicate becomes more abundant, the layers of interposed hydrate are submitted to attractions which interfere with and disturb, instead of mutually aiding, each other, that above this term, that is to say when the silicate is in too small a quantity, the layers of hydrate may still solidify, not so soon, nor wholly by the direct action of the silicate, but by the influence of the particles nearest the silicate, which, in measure as they solidify, react in their turn upon others: as in saline solutions, a crystal already formed may be the proximate cause of crystallization.

It may in the same manner, be conceived that hydraulic mortars have need of moisture rather than dryness, because the water preserving to the molecules a certain mobility, permits their arranging themselves in juxtaposition by the proper facets. It must not however be concluded that soft mortars would be preferable to mortars in stiff paste: because the water augmenting too much the distance of the molecules, would throw them beyond the sphere of mutual attraction: hence one of the causes why hydraulic mortars are generally less hard on the surface than in their central parts, while it is the reverse with all mortars made of fat lime and hardened in the air.

### § 33. *On the influence of the dissolving action of water.*

This fact has relation to another cause on which it is important to insist.

When hydraulic mortar is immersed in the bottom of any vessel, two opposite molecular forces are set in action: on the one hand, the action of the silicate of lime on the hydrate, and on the other, the solvent force of the water with respect to this same hydrate. The water being supposed tranquil, the lower portions of it dissolve the lime: but as this water becomes more dense it remains at the bottom, without power of removal; and the lime thus dissolved cannot be transferred to the upper portions of fluid except by the play of affinities—by a transmission analogous to that of carbonic acid in the interior of mortars made of fat lime. However that may be, the portion of water in immediate contact with the mortar losing its solvent power in proportion as it approaches the term of saturation, an equilibrium will soon be established between the two opposite molecular forces, and then all solution will cease. But if the superficial layer of mortar has lost a small portion only of its hydrate, this equilibrium, will, as regards the progress of solidification of the mortar, be only instantaneous: this layer might in fact continue to take cohesion from the influence of the under layers of mortar not attacked by the water.

If, on the other hand, the liquid be agitated, in order to render the saturation uniform throughout the mass of fluid—or rather, if the mortar be immersed in running water, it may happen that the exterior layers of mortar will, little by little, lose all, or the greater part, of their hydrate; but this effect not being brought about instantly, the interior layers would be protected for a time sufficient for them to harden beyond its solvent power before becoming, in their turn, exposed to the action of the water. We can conceive, therefore, that mortars may wash away for a certain depth: and that thickness may be an indispensable condition to the success of the solidifying process.

### § 34. *Influence of Quartzose Sands.*

As the practice is to use hydraulic limes, not pure, but mixed with sands, it is important to study the influence of these sands on the induration of mortars. We shall speak here only of quartzose sands, which are the most common.

It is demonstrated by experiments that caustic lime, cold or hot, is without any action on quartz in discernible particles: if, then, it adds to the quality of hydraulic mortars, it can only be because, 1st. it augments the density of the mass, and thus prevents its being brought to the state of soft mortar by being too easily permeable to water: or, 2nd. because its adherence to the lime, however feeble it may be supposed to be in the first instance, is an accelerating cause of crystallization. That this should be so, it is not necessary to suppose that the sand exercises a chemical action on the lime: because we know, for example, that in the preparation of rock-candy, and of verdigris or acetate of copper, &c. it is only necessary to stretch threads, or place sticks of wood, in the solutions, to determine the crystals to group around them like clusters of grapes, while none show themselves any where else. Sands in this, do no more than aid the tendency of hydraulic limes to take cohesion; and their influence is null when this tendency does not exist, as for example in fat lime. If the experiments with this last lime be attentively examined, it will be seen that they harden better alone than when mixed with sand: that the particles of hydro-carbonate have greater cohesion amongst themselves than adhesion to sand; whence it naturally follows that sands which divide the mass most thoroughly, that is to say, the finest sands, are the worst, because in an equal section the extent of surfaces in contact is the greatest. The contrary takes place in hydraulic limes, according to Mr. Vicat. If some experiments of General Treussart do not accord with these ideas, it seems to be owing to the too great quantity of sand used in his mortars.

### § 35. *On the solidification of deteriorated hydraulic limes.*

We have seen, at the commencement of this article, that hydraulic limes slaked spontaneously in the air, and not used for some time, lost their energy, more and more. We will add an analogous fact that we have had occasion to observe; it is that the hydraulic lime of Doué preserved for two years in flagons, well stoppered, so as to prevent any change of air, or the absorption of humidity, remained in fragments it is true; but these fragments had lost the power of slaking, and also of setting under water, after having been tempered like plaster. What has occurred in this case? This we have to explain.

It is well known that the limestone affording hydraulic lime, when treated, before calcination, with muriatic acid, leaves generally an insoluble residue composed of silex and alumine; but that immediately after calcination, the same stone, now become quick lime, is completely soluble, which shows the existence of a chemical combination: this being premised—we have taken hydraulic lime which had been slaked in air for two months; treated it with muriatic acid in excess, and it gave a considerable gelatinous residue: we have treated hydraulic lime preserved for two years in the same way, and the gelatinous residue was so abundant that we were forced to believe there could be no silex dissolved with the lime. But however that might be, is it not evident that the silicate of lime is decomposed, at least in part? that, therefore, in the case of the deterioration of hydraulic limes, the silex having taken cohesion, is only to be considered as being mixed intimately with the lime, and consequently can do no more than perform the office of puzzolana mixed in small doses with fat lime. Hence the great inferiority of the results, and the necessity of remedying them by the method of General Treussart.

### § 36. *On the solidification of Puzzolana Mortars.*

Let us pass now to the case of puzzolana mortars. According to what has been said before, an indispensable condition to the solidification of lime under water, is, that a small portion of this same lime be first rendered insoluble—each of the insoluble particles becoming the centre of attraction with respect to the surrounding layers of hydrate. Is this condition fulfilled on mixing fat lime with puzzolana? This is put beyond doubt by Mr. Vicat showing that puzzolanas have the property of precipitating lime from its solution in water, and that their energy is proportionate to the quantity of lime water they can thus precipitate. Whatever may be the cause of this property, whether it does, or does not, belong to a chemical combination between the lime and puzzolana—a combination difficult to conceive on account of the state of cohesion of the silex—a cohesion assuredly much greater than in deteriorated hydraulic lime, it is not less true that this fact suffices to establish a satisfactory analogy between the solidification of puzzolana mortars, and those made of hydraulic lime. It may be inferred from thence that the mixture of puzzolana with slightly hydraulic lime will give good results, because in such limes the proportion of hydrate would not be superabundant; with limes very hydraulic, it may be inferred, on the contrary, that this mixture would become injurious, because the proportion of lime would be too small, and there would result a kind of plastic cement, at the term of complete calcination.

The puzzolanas are mixed like sands, in the proportion of one and a half to two and a half in volume, to one of lime in paste. This proportion supposes, no doubt, much more silex, than is required to constitute hydraulic limes; but it must be remarked that in these limes, all the particles act in the most favourable circumstances possible, while in the above mixtures, they are collected in grains of some size, acting only by their surfaces, and their action being weakened by the cohesion that they already possess in a high degree.

### § 37. *On the solidification of Plastic Cements.*

Let us, in the last place, see to what degree the principles previously admitted will serve to explain the solidification of plastic cements, in the most general case; that is to say, as was explained at the end of article XVIII, section 25.

1st. In fat limes imperfectly calcined or super-calcined, the particles carbonated or super-calcined, requiring to be worked to make a paste with water, and being convertible into hydrate only with difficulty, it may be conceived to be not impossible that they play the same part as lime rendered insoluble by silex or by puzzolana, and that thus the commencement of hydraulic quality is obtained.

2d. In hydraulic limes imperfectly calcined, the particles of carbonate act in the same manner, but with this advantage that their influence on the solidification is increased by that of the silicate of lime which is present.

In the same lime stones carried to the second maximum of energy, the particles of carbonate are replaced by the equally insoluble super-calcined particles.

3d. In the septaria furnishing the ordinary plastic cement, the clay is too abundant to leave, at the term of complete calcination, the proportion of hydrate of lime necessary to a good solidification: the imperfect calcination, then, has for object to render the silex only partially soluble in acids so that it may the more resemble the mode of action of puzzolanas.

Lastly, at the term of super-calcination, the clay of these same lime stones passes to a state of less energetic puzzolana than at the term of complete calcination, and thereby leaves a greater proportion of lime susceptible of conversion into hydrate.

The developments into which we have entered relative to the solidification of mortars in general, are far, no doubt, from exhausting the subject; and require to be sustained by numerous experiments. We are fully aware of this; but our object not being to present a treatise on mortars, we have restricted ourselves to so much as is useful in understanding the operations of lime burning, which we have described.

[TO BE CONTINUED.]

## Mechanics' Register.

### LIST OF AMERICAN PATENTS WHICH ISSUED IN JULY, 1837.

### *With Remarks and Exemplifications by the Editor.*

(CONTINUED FROM P. 274.)

196. For a machine for *Reducing Thread Waste into Wool;* William Gray, Hebron, Tolland county, Connecticut, July 29.

Although this machine is for the same purpose as that noticed at No. 170 for the same month, it is not the same in construction. By referring to No. 170 it will be seen that the separating the waste thread into its original fibrous state is to be accomplished by it, principally, by beating against slats, or knives. In the present machine the reducing is principally effected by the operation of rollers set with points, between which it is passed. The claim made is to the reducing by "passing it successively between feeding rollers on to reducing rollers, whence it is delivered on to endless aprons, and pressed by pressing rollers, preparatory to its being again acted upon by reducing rollers." The pressing rollers upon the endless apron press the partially reduced thread into a bat, preparatory to its being again acted upon by reducing rollers.

197. For improvements in *Cooking Stoves;* Edwin Reed, West Bridgewater, Plymouth county, Massachusetts, July 29.

The claim made in this stove is to the particular arrangement of the dampers, so as to govern and direct the fire; to certain peculiarities in the construction and direction of the flues, and to the thereby heating those parts effectually which most require it. There is more novelty in this than in the greater number of stoves offered for patents, and we doubt not that it will operate well, and from good materials prepare a good meal.

198. For an improvement in the manner of constructing *Ovens for Stoves;* David W. Barker, Clyde, Wayne county, New York, July 29.

This oven stands above the stove, like a closet, or book case. It has shelves upon which to place the viands, and doors which open on the front and back. The ends and top are double, forming flues from the stove below it to the pipe which rises from the centre of the top, there being valves to govern the draught. The claim to the "oven is the particular manner in which it is connected to and combined with, the fire place, or stove; that is to say, standing above and behind the fire chamber, with a flue leading therefrom under it, and up at each end only of the oven, which oven has doors at back and front, in the way described."

199. For improvements in the framing of *Locomotive Steam Engines;* Ross Winans, Baltimore, July 29.

This patent is taken for a particular manner of framing the carriage part of the locomotive, and of covering the sides of the framing with continuous sheets of iron, and is particularly adapted to the kind of engine built by Mr. Winans.

200. For an improved *Coal Cooking Stove;* William Kenney, Louisville, Jefferson county, Kentucky, July 29.

We can only again repeat as regards this stove, what we have said respecting many others, that the claims are founded on the manner of directing the flues, and of governing the passage through them by means of valves differently situated. It will readily be believed that the differences are in many cases very trifling, consisting sometimes of little more than a change of shape, which although it may not be calculated to make any material change in the action of the apparatus, will be considered by the *inventor*, as a thing of primary importance, the denial of a patent for which would be an outrage upon genius, deprive him of fortune, and the public of the benefits of a magnificent discovery, unless he should give it as a free will offering.

201. For an improvement in the *Apparatus for blowing the fire in Locomotive Steam Engines;* Ross Winans, Baltimore, July 29.

In the engines used on the Baltimore and Ohio railroad, anthracite has been generally used as a fuel, and some of these engines have been put upon other roads. Where this fuel is employed it has been found necessary to quicken the combustion by a blowing apparatus, and this patent is taken for an improvement upon such an apparatus formerly used.

The improvements claimed are "first, the varying, increasing, and regulating, the blast created by the fan wheel, by contracting or enlarging the passage, or aperture, through which the steam issues on to the fan wheel, substantially in the manner and for the purpose described. Secondly, the placing of the steam and fan wheels upon an upright shaft, and the arrangement of the different parts in conformity therewith, which enables me to combine the steam and fan wheels in a convenient and compact form for the use of locomotive engines."

The fan wheel is driven by the action of the waste steam, as in the engines of the late Phineas Davis, whose patent is now the property of Mr. Winans.

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202. For improvements in *Locomotive Steam Engines;* Ross Winans, Baltimore, July 29.

This patent is taken for the manner in which the patentee has combined a vertical boiler with cylinders placed horizontally; and for the manner in which he has combined these with a spur and pinion wheel shaft, which operates upon the road wheels. There is much skill displayed in the mode of arrangement and combination, which are made clear by the drawings appended to the specification, and which cannot be understood without them.

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203. For an improved *Cooking Stove;* James Richardson, Poultney, Rutland county, Vermont, July 29.

This is a square stove, with a fire place resembling that in Stanley's rotary. The top plate also has projecting rims connected together by semicircular flues, as in the top of Stanley's stove. Behind the fire there is an oven, under which there is a flue, for the passage of heated air. The patentee states that " The novelties in this stove are, *First,* That the fire and heated air may be driven downwards through the openings in the grate, under and past the oven, while the grate and fuel are placed at different heights above the top part of the flue, under the oven, and at a higher elevation than the oven bottom. *Second,* In the oven there is a horizontal plate, covering the whole size of the oven at the bottom, and resting about one inch above it. This plate has several oblong or tapering holes or apertures therein, which are from one to nine inches in length, and one inch wide at the widest part. These holes or apertures commence near the back and cooler parts of the oven plate, and run towards the front part of the oven, diminishing in length as they approach the centre of the plate. This plate is called the upper, or movable, oven plate. The object of the last described plate, with apertures therein, is to assist in equalizing the heat in the oven, by discharging the heat which is created in the under oven bottom through these holes, to the back, or cooler part of the oven." The claims made are in accordance with the foregoing statements.

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204. For improvements in *Locomotive Steam Engines,* by which they are adapted to undulating and curved roads; Ross Winans, Baltimore, July 29.

The claim under this patent will afford a good general idea of the principle of regulation, and of the mode of procedure by which this principle is to be carried into effect.

"What I claim as new in the foregoing specification, and for which I ask an exclusive privilege is:

"*First.* The connexion of the power to four or more wheels, and the use of much larger cylinders than usual, in proportion to the weight of the engine, expressly with a view to, and in combination with, the cutting off the steam at different portions of the stroke of the piston, by means of which arrangement and combination, the object before stated, of adapting locomotive engines more perfectly to undulating and curved roads, to heavy and light loads, and to slow and fast speed, than heretofore has been effected.

"*Second.* The use of two, or more, arms operating on the slide valves, admitting the steam immediately to the cylinders, for the purpose of cutting off the steam at different portions of the stroke of the piston, as before described, thereby economising the steam, and consequently the fuel, and better adapting the engine to the duty it may have to perform, with different loads, and on varying grades of the road. The use of several cams, or of one cam so constructed as to perform the office of several, as herein-before described, I believe to be new in itself, separate and apart from the combination herein claimed, and applicable to every species of locomotive engine with advantage, and, as such, I claim a patent for it. The cutting off the steam at a portion of the stroke by a cam operating on the slide valve, has been long known and used on locomotives and engines; but the change in the time of cutting off the steam, as described herein, and thus being able to work the engine at full, half, or other, stroke, at pleasure, while the engine is in motion, has not before been done by a cam, or cams, operating on the same valve. An arrangement has been used for cutting off the steam at some one portion of the stroke, and changing from that to full stroke, at pleasure, while the engine was in motion, similar to that practiced in most of the steamboats of the present day, by having a throttle, or separate valve, moved by a cam, or eccentric, or crank, and so arranged as to cut off the steam at a portion of the stroke when desired. This, however, does not interfere with either of my claims, inasmuch as my *second* claim is for a mode of effecting the cut off by means of the same valve that admits the steam to the cylinder, and without a separate valve; neither does it interfere with my *first* claim, inasmuch as the cutting off the steam, and working at full stroke, at pleasure, has not been done in combination with the arrangement of connected wheels and large cylinders, as herein described—and which arrangement, in combination with the cutting off the steam, as herein described, is of the utmost importance in effecting the object of my invention, to wit, the adaptation of the locomotive engine to undulating and curved roads more perfectly than heretofore, or to roads where considerable variation in the power of the engine is required."

205. For apparatus for *Heating Water for Steam Boilers;* Ross Winans, Baltimore, July 29. (See specification.)

296. For an improved *Revolving and Sifting Grate;* Enos B. M. Hughes, City of New Haven, Connecticut, July 29.

This is a grate which may be set in an open fire place as a substitute for the ordinary grate for burning anthracite. It has flat ends, which may be made oval, and between these ends there are bars which continue all round, those constituting the upper part being made to open for supplying fuel. The ends are each made of two cast iron plates, the innermost of which has a rim to contain a lining of fire brick; and from the outermost of each extends a gudgeon upon which the grate is supported, and upon which it is made to revolve, for the purpose of sifting out the ashes.

Claim. "What I claim as my invention, is a revolving grate, with non-conducting ends, and all sides formed with open bars, which grate confines the burning coal, and sifts and cleanses it from ashes, and other small incombustible particles. And I claim only what is necessary to the construction of a grate which combines non-conducting ends, all its sides formed with open bars, and a revolving motion, as described."

Grates suspended upon gudgeons, and having bars all round, are not new, and could not be claimed alone, and of this the patentee seems to be aware; the nonconducting ends, in a grate so suspended, is the only novelty, and this must be understood as the basis of the combination claimed.

207. For an improved mode of fixing *Weather Strips to the Bottoms of Doors*; Isaac D. Brower, New York, July 29.

The weather strip used is a strip of metal let into a groove along the lower edge of the door, and closing, when down, against a rebate along the sill. The strip is attached, in the middle, to a sliding bolt enclosed within the framing of the door, and it is raised by the action of the knob which moves the spring-bolt of the lock, by attachments contained within the frame work. The closing of the strip is effected by a sliding rod which projects out from the hinged edge of the door, the pressure of which against the rebate in the door frame insures the descent of the bolt and the strip to which it is attached. The claim is to the arranging and combining the respective parts, so as to operate upon the weather strip, in the manner described.

The arrangement is made with much ingenuity, and we perceive but one difficulty in the way of its action; we feel assured that the appendages to the sliding bolt of the lock, by which the strip is to be raised, will cause the handle to turn with some difficulty. We apprehend, also, that the application will be too costly for general adoption.

208. For *Paddles to be used as Ice Breakers and Propellers:* Washington Van Dusen, Kensington, Philadelphia county, Pennsylvania, July 29.

The paddles used in this boat are fixed upon jointed frames, which are actuated by crank motion, in such a way as to cause them to dip into, and leave the water nearly at right angles to its surface. The paddles are to rise entirely out of the water, and as they are to be used as ice breakers, they are to be made of iron and steel. The crank is of considerable length, say five feet, and the paddles, or breakers, are brought into contact with the ice when the crank is at its point of rapid descent.

The patentee notices the previous use of paddles operated by crank motion, and points out the difference in construction, and action, of those used by him. The claim is to "the method of operating the paddles, or ice breakers, by means of a crank at one end of a crank frame, having at the other end a vibrating frame, as set forth. Also, the employment of such a paddle frame lengthened out, and sliding back and forth, horizontally, between guides, whether used for breaking ice and propelling at the same time, or for propelling simply."

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209. For *Bandages, Pads, &c., for Hernia, &c.;* Robert Thompson, M. D., Columbus, Franklin county, Ohio, July 29.

The patentee claims to have made improvements "in the mode of constructing bandages, pads, and other articles connected therewith, for the purpose of giving support to debilitated portions of the human system, and of effecting a cure, or producing relief, in cases of hernia, prolapsus, and other similar affections.

The instruments used are necessarily various in their construction, as they are to be applied to several different objects. The claims made are to " the employment of perinæal straps, in the manner set forth. The manner of making and adapting the abdominal bandage to the form, and to the support of the abdomen, by the employment of an elastic band of webbing along its lower edge, serving as a constrictor to it. The formation of a pad for hernia, by taking an impression of the part to which it is to be applied, for the purpose of procuring a pad possessing the exact form thus obtained, by casting, carving, or otherwise; and the mode of applying such a pad by confining it in its place under a bandage unattached thereto, or to any of the usual appendages of such pads. Also the employment of a spiral pad combined with the elastic strap proceeding from what I have denominated the abdominal portions, or bandage, and uncombined with a steel or other spring with which such pads have heretofore been connected, for the purpose of effecting a counter pressure, which makes no part of the object had in view by me in its employment. And, lastly, the use of a forked strap, having its hinder, or forked ends, attached to the back portion of the pelvic strap, giving support to the hips, as they proceed towards the pad from which they bifurcate."

But a very imperfect idea can be formed of the foregoing devices, without the drawings which accompany the specification. Some of the particulars named, are, however, sufficiently tangible, and as we believe, new. In the use of bandages we think that but little room is left for novelty of invention, and we believe that they rarely, therefore, afford sufficient ground for a claim under a patent; but when previous use of such as are identical with those claimed cannot be shown, the office grants a patent, and the risk of sustaining it is, of course, with the claimant.

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210. For an improved *Rotary Steam Engine;* David Grannis and David E. Brand, Collins, Erie county, New York, July 29.

The claim under this patent is to "the manner of working the draw buckets by means of pins working in grooves, or upon guides made upon the inside of the heads of the cylinder." The machine belongs to that class in which there are two valves, "draw buckets," against which the steam is to act alternately as one cylinder revolves within another. The only novelty is in the mode of withdrawing the valves, by means of eccentric grooves; a thing which has been effected in various ways, some, of course, more simple, and so far better, than others, but the best of them not approaching a single step towards the removal of those deep seated objections which lie against all rotary steam engines, and in an especial manner against those in which there must be close fitting valves, to open and close in a revolving apparatus. We wish that we could bestow a word of praise in the present case, but as we have no hope, we cannot attempt to inspire any.

211. For a machine for *Dressing Sawed Shingles, &c.;* Geo. L. Day, Union, Browne county, New York, July 29.

The shingles are to be dressed by means of cutters upon a cutter wheel, much in the manner of those used in some planing machines. The principal novelty in this machine is the manner of arranging and governing the action of the feeding rollers, by which the shingles are guided, and the claim is to this peculiar arrangement.

212. For a *Machine for Cutting Screws;* Joseph Blackhall, city of Albany, New York, July 29.

There is very little novelty in the *invention* which forms the subject of this patent. Three poppet heads, in a line with each other, are placed upon a suitable bed; through collars in two of these passes a shaft or mandril which has forceps at one end for gripping the piece which is to be cut by passing it between dies in the third head. The mandril is to be turned by a winch, or otherwise. Some of the things claimed are of doubtful originality, and we do not see any which render this machine superior to others that have been used for the same purpose.

213. For improvements in the *Machinery for Breaking and Dressing Hemp and Flax;* Chapman Warner, A. T. Mixsell, and E. I. Horn, Belvidere, Warren county, New Jersey, July 31.

*Claim.* "What we claim as our invention is the manner of constructing the breaking apparatus as herein described, consisting of a vibrating frame of beaters, operating between two stationary frames adapted thereto, and having the hemp or flax fed in on each side of the vibrating frame, by the aid of clamps, carried forward by an endless chain or band. We claim also the manner of forming the dressing apparatus, with its knives affixed upon a hollow drum or cylinder, and having a fan wheel within it, operating in the manner and for the purpose set forth. We likewise claim the vibrating frame of the hatcheling apparatus, in combination with the cams, or guides, constructed substantially as herein fully made known."

It will be seen by the foregoing claims, that the construction of this machine cannot be readily given without the drawings. In its general operation it resembles some others, but there appear to be various provisions in most of its parts entitling it to the character of novelty. In an operation where so many machines have failed altogether, or but partially succeeded, we will not pretend to anticipate the fate of this; but in point of arrangement it has merit. The dressing apparatus spoken of "consists of a hollow drum, or cylinder, revolving horizontally, having dressing knives projecting from its periphery, and a fan or wind wheel within it, revolving in a direction the reverse of that of the drums, the wind from which passes out through mouths or openings in the periphery or drum, in the spaces between the dressing knives, the current of air passing out from the wind wheel opening the fibres, tending to keep them up against the dressing knives, and blowing out the shivers so as to separate them completely from the dressed hemp or flax."

214. For an improvement in the mode of *Printing and Drawing Checks to prevent Counterfeits;* John Dainty, Philadelphia, July 31.

This is one of those devices the ingenuity of which will not cause its adoption. One thing claimed is what the patentee calls a "safety bar," in which the amount is to be written in figures. A plan of combining figures and letters is also explained and claimed; also a particular mode of making entry in a register, or firm book.

If a person cannot find half a dozen merchants who will adopt a plan like the foregoing, if allowed to do so free of charge, the inference is a fair one that they will not pay for it for the sake of the parchment, the great seal, and the patent right.

215. For a machine for *Turning Mouldings and Beads;* Eli Coddington, Thompson, Sullivan county, New York, July 31.

This machine appears to be principally intended for turning such articles as broom and brush handles, which are simple in their form. The stuff to be turned is fixed by one end in a chuck in a collar and mandril lathe, and a sliding head, furnished with suitable guide pieces, and cutters, is forced up against it; in this head there are cutters so formed as to cut beads, hollows, or other simple members of mouldings, which cutters may be brought down upon the stuff in the proper places. It is to this part that a claim is made.

216. For an improvement in the *machine for bending the Tire of Wheels, and other articles;* Thomas C. Barton, New York, July 31.

The bending is to be effected by means of three rollers not differing materially from those frequently used for the purpose; but there is an adjustment of one of the rollers by the combined action of a frame, lever, and screw, which arrangement forms the subject matter of the claim.

217. For a *machine for drilling the tire of wheels;* Thomas C. Barton, New York, July 31.

The drill is fixed in a mandril running in collars; the devices which form the subject of the patent, are for fixing and using the drill more conveniently than heretofore, when applied to the drilling of tire, and the claim is confined to this particular arrangement.

218. For a *machine for Husking Corn;* Jonathan Cutler, Pickney, Windham county, Vermont, July 31.

Two iron rollers which may be thirty inches long, and an inch and a half in diameter, are fluted from end to end, and placed in a frame, where they are geared together, and made to revolve horizontally on suitable bearings, and nearly in contact with each other. The corn to be husked is fed down a wooden trough so as to fall between the rollers, the flutes of which seize the husk, and draw it off. The ears of corn are thus successively supplied, and pass off at the far end of the roller. The claim is to a machine constructed substantially in the manner of that described.

219. For improvements on *Drawer, Commode, and Cupboard door knobs;* David Hoffman, city of Baltimore, July 31.

The specification is as follows. "The nature of my improvement consists in inserting, or otherwise fastening, topically stained, painted, coloured, gilt, or silvered glass plates of various patterns and sizes, into stocks of wood, with either metal or wooden spindles; and for the purpose of variagating and increasing the brilliancy of the colours I place either coloured foil, coloured paper, coloured glass, coloured metals, or looking glass, underneath said plates according to the patterns required." The claim is to the knobs so made, as a whole; and if the whole of those made resemble the specimens deposited in the Patent Office, we apprehend that the patentee may not only claim, but actually keep the whole.

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220. For a new mode of constructing *Paddle Wheels for propelling Steam Boats;* William A. Douglass, Albany, New York, July 31.

By a particular arrangement of levers, joints, and slides, the buckets of the paddle wheel are to be made to enter and leave the water vertically, or at such angle as may be preferred. The same thing has been accomplished by other modes of construction, some of them less complex than that here proposed; so far, however, as the results of experience have been known, all devices of this kind have proved worse than useless, not in the slightest degree accelerating the speed of a boat, whilst they consume a part of the power of the engine, and are much more costly at first, as well as more liable to derangement, than wheels with the ordinary fixed paddle. The patentee claims the particular mode of construction invented by him.

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221. For a *Plough;* John Deats, Roxburg, Warren county, New Jersey, July 31.

The claims made in this plough, are to "the manner of forming the pattern of the mould board, so as to cast it to deliver from a single flask, with a tenon, or pin, cast near its front edge, in the manner, and for the purpose, described." There are also certain claims to the manner of constructing particular parts, as explained in the specification.

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222. For a new mode of *attaching Knives or Dirks to Pistols;* Robert W. Andrews, Stafford, Tolland county, Connecticut, July 31.

"The nature of my invention consists in so attaching a knife or dirk, to a pistol, or other small fire arm, as that the breech, with its lock, guard, and other fixtures, being separable from the barrel, shall serve as a convenient handle, or hilt to the knife, or dirk, making use of the blade as an essential means of connecting the breech, lock &c. with the barrel, to form the piece entire."

To the under side of the barrel, is attached, a sheath, or scabbard, which slides over the knife, or dirk, affixed to the stock, making, when in place, an entire pistol. The claim is to "attaching the scabbard to the barrel, and making it an essential part in holding the piece strongly and firmly together."

223. For improvements in the *machine for cleaning and dressing Feathers;* Samuel Sweet, jr.

There are two drums, or cylinders, one placed above the other, within a case, and an endless band or apron passes round these cylinders. The upper cylinder revolves on gudgeons, the lower lies in the apron, which it keeps stretched by its weight. The apron is set round with projecting points, the case being large enough to admit of their passing round with the apron. The feathers are to be contained between the apron and the case, and are agitated and carried round by the points; there being provision made to supply the requisite degree of heat. The claim is to "the revolving belt, with pins, or hands, revolving round two drums inside of a case adapted thereto, in the manner, and for the purpose, above specified."

224. For a *Locomotive Power Machine for removing Houses, &c.;* Stephen Compton, Almira, Chemung county, New York, July 31.

This machine consists of a combination of wheels and pinions upon suitable shafts, operating upon a windlass; from this windlass a rope, or chain, is to be extended to a house, stump, or other body to be removed. The machine is mounted upon wheels, and is so constructed that "the end of the frame towards the resisting body may be brought into contact with the ground, this end being armed with iron, and so formed that it will enter, and form a bearing against the earth, with a power of resistance proportioned to that applied. The claim is to "the mounting of such a machine upon a carriage, constructed in the way described, so that it may readily be removed from place to place, and that it shall anchor itself, or take firm hold in the ground, by the action of the power applied, substantially in the manner shown."

225. For *smelting Iron Ore by a composition of Anthracite and Clay as a fuel;* Joseph Lyon, Pottsville, Schuylkill county, Pennsylvania, July 31. (See Specification.)

226. For a *Stove for Heating and Cooking;* Rufus S. Payne, West Springfield, Massachusetts, July 31.

This stove differs so little from several others, that it is not worth while to give the claim, which is only to certain special matters of arrangement.

227. For *preparing Oleaginous Seeds for pressing;* James Crisswell Pittsburg, Pennsylvania, July 31. (See Specification.)

228. For a *Stove for Heating apartments;* Philip Willcox, Springfield, Massachusetts, July 30.

The remarks made on stove No. 226, will apply to that now under consideration; the claim would not make known the peculiarities of construction upon which they are now founded.

229. For a process for *removing Wool and Hair from Skins;* Benjamin F. Emery, Bath, Lincoln county, Maine, July 31. (See Specification.)

230. For an improvement in the construction of *Water Wheels;* Clayton Parker, and Robert W. Engle, Wayne, Warren county, Ohio, July 31.

This wheel, it is said, is to be "propelled mainly upon the undershot principle, and to revolve with its shaft vertical. "Its construction is peculiar, and would require drawings to make it known. The water is to pass down through openings near the periphery, which descend spirally, but differ in their arrangement and combination from others which have a resemblance to it. There is also a peculiarity in the mode of letting on the water, and of regulating its quantity. The claims are to "the giving to that part of the water wheel which is within the buckets, the form of a hollow drum, provided with openings, in its upper and lower heads, made in the manner, and for the purposes set forth. The raising or closing the gates of all the chutes simultaneously, substantially in the manner described. The plan of continuing one half of the buckets, down for about one half of the depth of the wheel, and the forming of an elbow in the other half of our buckets, half way down the wheel; thereby causing it to receive its main propelling power on the undershot principle, and to operate well in back water."

231. For an improvement in the mode of constructing *Rail Road Frogs;* George S. Griggs, Roxbury, Massachusetts, July 31.

"By a railroad frog is meant the rails at places, where two rails cross each other. The frog has heretofore been cast or constructed in one entire piece, forming the two crossing rails for the distance of from two or three, to seven or eight feet." It is stated that from the exposure to severe shocks, and wear, at these crossing places, they are liable to great and frequent want of repair; and the improvement described, consists in providing plates of steel which are to be bolted on to the cast frogs, the bolts having flush heads. These plates can be removed when required, and new ones substituted. The claim is to "the frog plates above described, and applied as aforesaid, of whatever materials formed, and however attached to, and connected with, the main body of the frog rails."

232. For an improvement in the machine for *Crimping Leather for Boots;* Moses S. Woodward, Marshalton, Chester county, Pennsylvania, July 31,

The improvement described consists, principally, in the means adopted for holding the leather in place whilst it is dried upon the former. The machine, in its general construction, is like several others used for the same purpose.

233. For an improvement in the mode of constructing the *Wheels of Locomotive Engines for ascending Inclined Planes*; Elisha Town, Montpelier, Washington county, Vermont, July 31. (See Specification.)

234. For a *Cooking Stove;* John Collins, Grafton, Worcester county, Massachusetts, July 31.

This stove has too much complexity in its individual arrangements to justify the attempt to describe them verbally. The claim is to "the manner in which the heat is communicated to, and diffused through the oven of the stove or baker, in the manner described."

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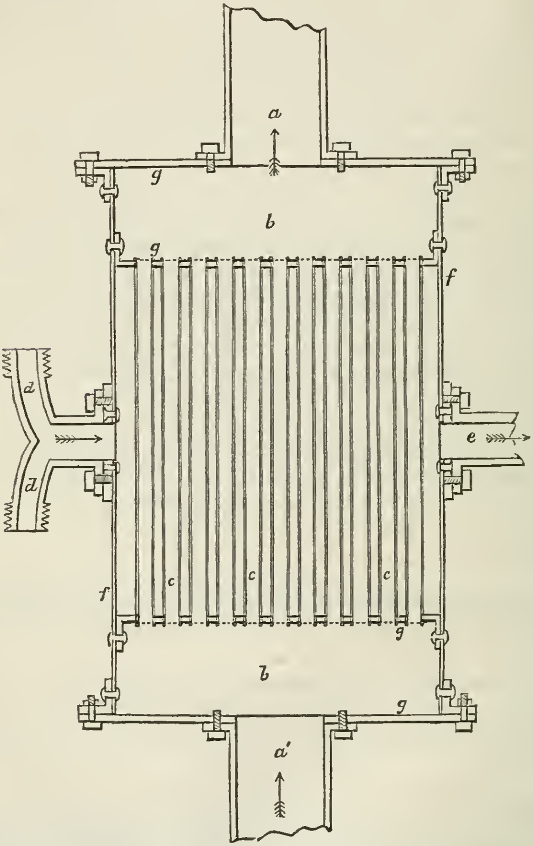
## Specifications of American Patents.

*Specification of a patent for an improvement in the mode of Heating the Water, which is forced into the boilers of Steam Engines by means of the Force Pump; granted to* Ross Winans, *Civil Engineer, Baltimore, Maryland, July* 31, 1837.



To all whom it may concern, be it known that I, Ross Winans, Civil Engineer, of the city of Baltimore, in the State of Maryland, have invented an improvement in the mode of heating the water which is forced into the boilers of steam engines, by means of the force pump; and I do hereby declare that the following is a full and exact description thereof.

The apparatus which I employ is intended to expose the water to the heating influence of the waste steam from locomotive or other steam engines, as the said water is on its passage between the force pump and the boiler. This apparatus may be differently formed, but, for the purpose of illustration, I will describe it in the shape in which I have essayed it, and which I have found to answer the intention perfectly well.

I make a cylinder of metal, *f*, *f*, which may be twenty-four inches long, and fifteen inches in diameter, for an ordinary locomotive engine; this cylinder has at each end two metallic heads, *g*, *g*, which may be four inches, more or less, apart; the interior heads are perforated with numerous holes into which are inserted small tubes *c*, *c*, say of three eighths of an inch in diameter, which tubes are firmly attached, or fastened into the openings in the heads, thus establishing a number of passages through from one of the spaces *b*, *b*, between the heads at one end of the cylinder, to the space at the opposite end. The waste steam pipe, *a*, from the engine enters the head at one end of the cylinder, and a similar pipe, *a*, passes out from the opposite end; and in its passage from one to the other the steam must necessarily pass through the small tubes above named, which are contained in what may be denominated an enlargement of the waste steam pipe. In the side of the cylinder, I make two perforations, *d*, *d*, *e*, opposite to each other, into which openings the supply pipe, between the pump and the boiler is firmly inserted, thereby causing the cold water, as it passes from one segment of this supply pipe to the other, to become heated by its contact with the tubes through which the waste steam passes. The upper part of the supply pipe, between the system of heating tubes and the boiler, is furnished with a puppet, or other, valve, opening towards the boiler.

Although I have described the steam as passing through the system of small tubes, and the water as surrounding them, it will be manifest, to any one having the slightest acquaintance with the subject, that this order may be reversed, and the same effect upon the water be still produced; and also that, instead of the tubes, a system of partitions, to be alternately occupied by steam and by water, will be substantially the same with the arrangement before described.

In those locomotives, or other engines, in which the waste steam is employed to drive a blowing apparatus, as is the case with those used on the Baltimore and Ohio rail-road, and some others, the waste steam is allowed to perform this office before it reaches the heating apparatus; the means of doing which will not require any description, as it will be perfectly manifest to every competent engineer.

What I claim as my invention, and wish to secure by Letters Patent, is the heating of the water in its passage from the supply pump to the boiler, by means of an apparatus substantially the same with that herein described.

Ross Winans.

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### *Specification of a patent for a new mode of Smelting Iron Ores by a mixture of anthracite and clay as a fuel; granted to* Joseph Lyon, *Pottsville, Pennsylvania, July* 31, 1837.

To all whom it may concern, be it known, that I, Joseph Lyon, of Pottsville, in the county of Schuylkill, and State of Pennsylvania, Collier, have invented, or discovered, an improved mode of smelting iron ores by the employment of a mixture, or composition, of anthracite and clay, as a fuel, which I call "*Clay-Coals*," and that the following is a full and exact description of the same.

My improvement consists in reducing anthracite to a coarse powder, or screening, and mixing, or mingling, it, either by hand or machinery, with such portions of clay and water as may be requisite to bring the mass, or aggregate, to a consistence that may be readily made into balls, or be taken up by hand, or machinery, in portions of any shape, or size; when these *clay-coals* are dried, they can be used as fuel in the manner that coke, or charcoal, is commonly used in the reduction of iron ores. I intend to mingle portions of the limestone, or other fluxes, in the composition of the mixture, and also some of the finer portions of the ore, when either, or both, of these additions may be considered useful.

I do not claim the discovery, or invention, of combustible balls composed of coal and clay, for these have long been known and used for divers purposes; but what I do claim as my invention, or discovery, and desire to secure by Letters Patent, is the preparation of anthracite, or the composition of *clay-coals* as herein set forth, to be used as a substitute for coke, charcoal, or other fuel, in its application to the purposes of smelting iron ores.

JOSEPH LYON.

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*Specification of a patent for a new method of Heating Flax-seed, and other oleaginous seeds preparatory to expressing the oil; granted to* JAMES CRISWELL, *Pittsburgh, Pennsylvania, July* 31, 1837.

To all whom it may concern; be it known, that I, James Criswell, of the City of Pittsburgh, and State of Pennsylvania, have invented a new and improved method of heating flax-seed, or other oleaginous seeds, preparatory to expressing the oil therefrom; and I do hereby declare that the following is a full and exact description.

The nature of my invention consists in conveying steam, by means of a tube, into a steam chest, flat on the top, with a rim round it; within which rim the seed is placed in such a manner as to expose it to the heat from the steam within the chest; the chest may be of any given size, dimensions, or construction, to suit the convenience of the manufacturer.

What I claim, therefore, as new, is the application of steam to the heating of flax-seed, or other oleaginous seeds, preparatory to the expressing the oil therefrom, by means of any apparatus so constructed as to expose the seed to the heating influence of the steam, no claim being made by me to the apparatus used.

JAMES CRISWELL.

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*Specification of a patent for a method of Softening Hides and Skins, and of removing wool, hair, and bristles from them; granted to* BENJAMIN F. EMERY, *Bath, Lincoln county, Maine, July* 31*st*, 1837.

To all whom it may concern, be it known, that I, Benjamin F. Emery, of Bath, in the county of Lincoln, and State of Maine, have invented, or discovered, a new and useful improvement in the method of softening hides and skins, and of removing wool, hair, or bristles, from them. This improvement is effected by the application of steam of the proper temperature to the hides and skins, instead of water, acids, or other materials.

For the purpose of softening dried sheep skins, for pulling the wool and tanning the skins, a room should be provided large enough to contain, suspended, as hereafter described, as many skins as it may be required to operate upon at one time, and made as nearly air-tight as it can be without much expense, say by tight boarding and shingling; with several small windows, or openings, with shutters, to admit or exclude the air, as occasion may require. I employ racks, consisting of rails, or strips of boards, or planks placed about three feet apart, and having tenter hooks inserted about four, or five inches from each other, precisely as they are now commonly used for drying sheep skins after they are tanned. As many of these may be put up in the steam room as will consist with the objects of not having the skins touch each other, and of permitting passages through them, to hang up, and take down, the skins. The steam may be generated in any kind of boiler, and conveyed by pipes from the boiler into the steam room; it is most advantageously discharged only a few inches from the floor, in the centre of the room. For a room about 12 by 15 feet square, and 9 feet high, a common potash boiler, having the steam secured, and forced into the room by a tin or copper pipe, of about two inches diameter would be sufficient, although an iron boiler resembling those used for steam engines is more convenient. Two windows of about two feet square, placed opposite each other would well answer for such a room: with the temperature of blood heat, the skins in such a room would be sufficiently steamed in about three hours, unless they were much harder than usual. It is easy to ascertain, however, by going into the room, when the wool is loose, and the skins are sufficiently pliable, taking care to lose no more steam, by keeping the door open, than is necessary. The process may be somewhat expedited by raising the temperature a little higher, although I should not advise raising it above 150 degrees of Fahr. for fear of injuring the skins. The softening will be expedited by wetting the skins or hides, before hanging them up.

Hides of neat cattle, and other large animals, may be softened for tanning in the same way; the rails and tenter hooks being larger and farther apart, in proportion to the size of the skins, or hides. The time required for softening, will also be longer in proportion to the thickness and hardness of the skins, or hides. In all cases, the skins and hides should be affixed to the tenter hooks by the shanks, so as to keep them moderately stretched.

Slaughtered hogs, instead of being scalded in the usual way, for the purpose of scraping off the bristles, may, also, be more conveniently scalded by steam, in a similar way, where the business of dressing them is carried on to a large extent. The hogs may be hung up by the gambrils, only far enough apart to permit the butcher, or dresser, to work between them. Hot steam should then be rapidly thrown into the scalding room; until it rises to the temperature of about 175, or 180 degrees, and if very rapidly done, to the boiling point (although this is rather dangerous,) when the room should be immediately ventilated sufficiently to admit of the operation of dressing. In order to keep the labourers employed, there may be two steam rooms, so that they may operate in one room while the preparation of the hogs, and the scalding, is going on in the other.

What I claim as my invention, and desire to secure by Letters Patent, is the application of steam, instead of water, or other substances, to hides and skins, for the purpose of softening such as are dried, and of removing the wool and hair from them, and to slaughtered hogs, for the purpose of removing the bristles.

Benjamin F. Emery.

*Specification of a patent for an improvement in the mode of constructing the Wheels of Locomotive Engines, for ascending Inclined Planes on Railroads; granted to* Elisha Town, *Montpelier*, *Washington county*, *Vermont*, *July* 31, 1837.

Be it known, that I, Elisha Town, of Montpelier, in the county of Washington, and state of Vermont, have invented a new and improved mode of constructing the wheels of locomotive engines used on Railroads, so as to ascend and descend inclined planes without the aid of any other power than that of the engine belonging thereto, to propel the same; called "Elisha Town's Improved Engine Wheel for inclined planes," and I do hereby declare that the following is a full and exact description.

The nature of my invention consists in attaching a wheel of proper dimensions, with a groove in its rim, similar to the wheels used to propel machinery by round bands, to the inside of such of the wheels of the *locomotive* that run on the rails on the level road, as the power of the engine is applied to, in propelling the engine car. At the commencement of the inclined plane, the ordinary rail stops, and another of the same shape, starts, but laid within the other, to correspond to the grooved wheels, and as the grooved wheels come on to this, it raises the other wheels from the ordinary rail, and the groove, by embracing both sides of the rail, produces sufficient friction to enable the locomotive to propel itself, and a train of cars, up the inclined plane.

The grooved wheel should be proportioned in size, and the bevil of the groove should vary in its inclination, to the steepness of the ascent to be overcome, and should be used only on the inclined plane.

It is proposed to use the ordinary kind of rolled iron rail, hardened, to run the grooved wheels on; but cast iron, or steel, of a similar shape, may be used.

For the cars, there should be a set of wheels with two bearings to each, with a flanch in the centre, between the bearings; one bearing for the bevil rail, and the other for the inclined plane.

The rails to the inclined plane must run past the ends of the horizontal rails, sufficiently far to have the wheels pass properly from one set of rails to the other.

What I claim as my invention, or improvement, and desire to secure by letters patent, is the application of grooved wheels to locomotives to enable them to propel themselves and a train of cars up an inclined plane.

Elisha Town.

*Specification of a patent for manufacturing White Lead, and other salts of lead; granted to* Homer Holland, *Westfield*, *Hampden county*, *Massachusetts*, *March* 13*th*, 1836.

To all to whom these presents shall come, be it known, that I, Homer Holland, of the town of Westfield, county of Hampden, and State of Massachusetts, have invented a new and useful improvement in the process for oxidizing metallic lead; and for making and producing carbonate of lead, or the pigment commonly known by the name of white lead, which improvement has not heretofore been known or used, and that the following is a full and exact description of said improvement, sufficient to distinguish the same from all things before known, and to enable any person skilled in the art or science of making and producing the salts, acetate and nitrate of lead, from any oxide, or the carbonate of lead, to apply and use said improvement in the making and compounding of the same.

The invention consists:

1st. In an improvement in the method of applying the conjoint action of friction, air, and water, to metallic lead, by placing fragments of this metal in revolving lead cylinders, or chambers, so as to produce a fine powder or pulpy suboxide of lead, for making or producing the commercial salts, nitrate and acetate of lead.

2nd. In combining carbonic acid, from the atmosphere, directly with this suboxide, as it is formed in the cylinder by the addition of carbonate of soda, or other alkaline carbonate, so as to produce, or make, the carbonate of lead, or the pigment known as white lead. To effect the oxidation of the lead, I put coarse shot, or other fragments of unalloyed lead, into a leaden cylinder, or chamber, about four feet in length, and three in diameter, made to revolve, horizontally, upon an axis of flanches. The leaden cylinder, or chamber, is enclosed in a strong and tight wooden case; air is admitted by perforations of the cylinder, at the ends, near the axis; soft water is put in the chamber, sufficient to cover the charge of shot or fragments. The cylinder is made to revolve eighteen or twenty times in a minute, by the application of any force, and the electro-chemical action of the friction, air and water, produces a fine, pulpy suboxide of lead which is strained out by removing a bung from the side of the cylinder, and placing therein a hollow tube, leading to a sieve, or strainer, resting in a canal, or trough, which conducts to a reservoir.

This pulpy suboxide sufficiently freed from water, is readily combined with acetic acid, this giving "sugar of lead," and, with nitric acid, producing nitrate of lead. To make carbonate of lead, the process is identical with the above-described for the suboxide, with the addition of about six or eight ounces of the carbonate of soda to each gallon of water used in the cylinder. The cylinder is revolved several hours in producing the suboxide for the salts of lead, and from twelve to sixteen previous to straining out the carbonate, or white lead, which is conducted, as above described, to a vessel armed with an agitator and washed by decantation with pure water, once or twice, to free it from alkali, when it is to be dried by any convenient means, becoming the pure carbonate, "or cream," white lead of commerce. In this process, for white lead, the use of vinegar and of acetic, or acetous acid in any shape, is avoided, and the health of manufacturers is preserved from the fumes of the volatile peracetate of lead so deadly in the ordinary process. The foregoing process I prefer; but the revolving chambers may be cylindrical, square, or polygonal, of any size and length. The lead lining of a wooden cylinder may be of sheet lead, or cast in cylinders to fit the wooden case, or carcass, and the cylinders are to be renewed from time to time, as they frit away. The number of cylinders, their weight, and the charge, will depend on the force employed, and the extent of the manufacture. Each cylinder (principally the lead chambers) may weigh six hundred pounds. The charge added, from one hundred to one hundred and fifty pounds of fragments, and the necessary water and carbonate of soda. The lead fragments may be shreds of sheet lead, shot, or fragments produced by pouring melted lead through a colander into water. Antimony and other alloys of metals are often mingled with lead in the shot of commerce, and unfit them for this process. The alkali preferred is soda, as this has the strongest affinity, or attraction, for oxygen and carbonic acid, and is less liable to form an hydrate. The pulpy suboxide may also be conveniently carbonated in the vessel employed for decantation, as it is armed with agitators, by passing into the pulpy suboxide, as it is withdrawn from the cylinders, carbonic acid produced by the combustion of charcoal, from fermentation, or from the decomposition of carbonate of lime, or chalk, by sulphuric, or hydrochloric acid. The decanting vessel, again, may be used conveniently in removing a disagreeable yellowness from pure carbonated lead by minutely mingling a trifle of indigo, or blue smalts, with the carbonate of lead. I claim as my invention and improvement,

1st. The application of the revolving cylinders, or chambers, as above described, to the fritting, comminution, amalgamation, or converting of metallic lead into the fine, pulpy suboxide of lead, for the salts, acetate and nitrate of lead, or carbonate of lead.

2nd. The carbonating of the above described suboxide, as it is formed in the cylinder, by the addition of an alkaline carbonate, or by passing into this pulp directly, carbonic acid, giving immediately white lead.

Homer Holland.

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## Progress of Practical and Theoretical Mechanics and Chemistry.

### Notices from the French Journals. Translated for the Journal of the Franklin Institute, by J. Griscom.

*New observations on Magnesian Hydraulic Lime.* By M. Vicat. (Academy of Sciences, Jan. 16, 1837.)

M. Berthier has excited some doubts with respect to the chemical fact, which I recently communicated to the Academy,—namely, whether magnesia, when it occurs in the proportions of thirty or forty parts, can render hydraulic, forty parts of very pure lime.

Through deference to the opinion of this learned chemist, I have verified afresh the synthesis which served as the basis of my conclusion; and, in order to remove the possible causes of error, I desired the chief Engineer of mines, Gueymard, (in whose laboratory I was operating) to select and verify himself the carbonates of lime and magnesia, destined for the experiment.

He consequently placed at my disposal—1st. white marble from Val-Senestre, (Isère) which, in 100 parts contained;

| | | |
|---|---|---|
| Silica, | 0.068 | 100 |
| Carbonate of Magnesia, | 0.020 | |
| Carbonate of lime, | 99.912 | |

2nd. Some Carbonate of magnesia of the shops which contained;

| | | |
|---|---|---|
| Magnesia, | 46.00 | 100 |
| Carbonic acid, | 51.60 | |
| Water, | 2.40 | |

The silica in the lime stone from Val-Senestre, does not amount, as we perceive to $\frac{1}{1000}$, and is therefore an insignificant ingredient.

Having calcined several fragments of the limestone, until the carbonic acid was almost completely expelled, I obtained lime, pure, within a thousandth at least, and I weighed 44 parts of it. I weighed also 80 parts of carbonate of magnesia, representing 36.80 of anhydrous magnesia. The lime was slaked into a cream, and mixed with the magnesia previously pulverized and passed through a silk sieve. After long trituration, the mixture, still too liquid to be managed, was partially dried, then divided into small balls, and placed in the muffle of a cupelling furnace, where it was exposed during four hours to a red heat.

The factitious lime thus obtained promptly dissolved with active effervescence in water. Reduced to a paste of good consistence, and placed in the bottom of a vessel and covered with water, it set in the course of a week, and on the 9th day the wet surface bore, without depression, a common knitting needle loaded with 300 grammes, (=10 oz.)

This second experiment therefore fully confirms the previous results, and solves the doubts of the honorable Academician alluded to. It explains satisfactorily the hydraulic character of the natural limestones of Sardin, (Dordogne) whose composition, taking the mean, is

| | |
|---|---|
| Silica, . . . | 5.00 |
| Alumine, . . . | 2.00 |
| Oxide of iron, . . . | 0.40 |
| Carbonate of Magnesia, . . | 42.00 |
| Carbonate of lime, . . . | 50.60 |
| | 100.00 |

In fact, if magnesia served merely as an inert material, like fine sand, for example, the lime of Sardin, containing pure lime and silica in the proportion of 100: 10 would be only half hydraulic,—whereas its well established qualities place it in the rank of good common hydraulic lime. The large quantity of magnesia which it contains, thus evidently supplies what it was wanting in silex.

In granting the accuracy of our results, M. Berthier, however, pretends that the principle is of no consequence in practice;—but there is perhaps a little too much haste in the desire to set bounds to the useful application of this or that principle; for, if I am correctly informed, the publication of my first note would have had some effect in recalling the attention of builders to the dolomites which have been rejected in various places, because, giving up to the acids only five or six hundredths of the argillaceous residue they despaired of obtaining from them a lime sufficiently hydraulic.

*Mr. Dumas* recollected:—that Mr. Fuchs had published a few years ago, in Bavaria some observations tending to prove that magnesia had a useful action in hydraulic mortars. He endeavoured especially to point out the great advantage that might be obtained by using dolomite, and he proved that with a puzzolana which produced only a very moderate effect when used with fat lime, mortar of an excellent quality was obtained in combination with magnesian lime.

Jour. des Mines, 3liv. de 1837.

## *Fossil Bones.*

Among the fossil bones discovered on the borders of the Jamma, in India, some are of a blackish brown, shining, brittle, and having a conchoidal fracture. Spec. grav. 415, and their composition proves to be,

| | |
|---|---|
| Phosphate, and carbonate of lime, | .175 |
| Red oxide of iron | .765 |
| Water, | .060 |
| | 1.000 |

The bones found on the Jamma, belong to elephants, hippopotami, Deer, Antelopes, Cattle, Horses, Hogs, Water Rats, Saurians, and others much resembling Camelopards. Idem.

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## *On the Carbonate of Magnesia of Southern India.* By M. Prinse, (Asiat. Jour.)

This mineral which is found at Salem, is met with in veins of limited extent, from one inch to a foot in thickness, and sometimes also in beds. It snaps when applied to the tongue. Sp. gr. from 2.87 to 2.887. It is a pure neutral, anhydrous carbonate. When calcined, and water is poured on the magnesia, the latter absorbs about $\frac{1}{10}$ of its weight of the liquid with a disengagement of heat, and the water does not escape by the action of sulphuric acid in a vacuum. Idem.

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## *Analyses of two Vegetable Soils in the vicinity of Puiseaux, department of Loiret.* By M. P. Berthier.

1*st. Soil eminently adapted to the cultivation of Saffron.*—Large quantities of this plant have been grown around the town of Puiseaux, from time immemorial. It is not, however, every part of the country, that is fit for its culture;—only land of the best quality is devoted to it. The specimen subjected to analysis was taken from a field reputed to be excellent.

The soil is of a blond, verging upon a brown colour. By sifting and levigation only 15 per cent. of stony matters, in general very small, were separated, rarely of the size of a pea. These grains are fragments of freshwater limestone mingled with quartz. I found in the native soil:

| | |
|---|---|
| Carbonate of lime, | .370 |
| Silex and quartzose sand, | .454 |
| Alumine, | .093 |
| Oxide of iron, | .020 |
| Water and organic matter, | .063 |
| | 1.000 |

Agreeably to the ordinary composition of clay, there is reason to believe that it amounts in this soil to 30 per cent. including .247 of quartzose sand; but this sand is so fine, it is absolutely impossible to separate it by levigation.

When the soil of Puiseaux is moistened, it absorbs much water, and becomes a viscid paste, which loses its consistency by drying. It is very permeable to roots, on account of the great proportion of sand and grains of calcareous matters which it contains.

2nd. The second soil was taken from the park Gauthier, which has hitherto been kept in wood. It is of a blond colour. It forms a pasty mass with water, which when dry contracts and splits, and the pieces assume the consistency of crude pottery: yet, by calcination, it acquires very little solidity. The analysis of this soil gave.—

| | |
|---|---|
| Carbonate of lime, . . | .010 |
| Silex of quartzose sand, . | .785 |
| Alumine, . . . | .110 |
| Oxide of iron, . . | .030 |
| Water and organic matter, . | .065 |
| | 1.000 |

This soil must contain about 33 per cent. of clay and consequently .565 of quartzose sand.

The analysis shows that the soil of park Gauthier, has very nearly the same composition as the non-calcareous portion of the Saffron soil, and that it might be improved by adding half its weight of limestone earth in powder. Idem.

## *Analysis of a vegetable soil from Cuba.* By M. P. BERTHIER.

This soil was sent to the laboratory by M. Mollien, consul general of France, at Havanna. It is that in which sugar, coffee and tobacco are raised with so much success. It is red, resembling an earthy ferruginous mineral. It is in small agglomerated masses, but is very easily crushed. No stony matters are discoverable, but vegetable remains are conspicuous, apparently proceeding from sugar cane. It exhales a disagreeable odour, analogous to sheep dung. It forms a paste with water, which contracts on drying, without splitting, and acquires much tenacity. It would form an excellent material for red antique pottery.

By levigating and sifting, only two per cent. are separated of white calcareous fragments, and vegetable fibres. Dried at the boiling heat it loses .99 of hygroscopic water. It contains:

| | | |
|---|---|---|
| Carbonate of lime, . | .080 | |
| Peroxide of iron, . . | .140 | |
| Oxide of manganese . . | .010 | |
| Silica . . . . | .336 | clay .506 |
| Alumine . . . | .170 | |
| Water and organic matter . . | .250 | |
| | 9.86 | |

The organic matters are equivalent to .04 of carbon.

This soil must retain water very firmly, and also acquire great stiffness, or hardness, in drying by the sun, and it is difficult to conceive how the roots of plants can get through it. Idem.

## *Analysis of the Sulphate of Iron of Nordhausen.* By M. P. BERTHIER.

This salt is that from which the smoking sulphuric acid of Nordhausen is made. It is in amorphous pieces, has a granular fracture, white inside, and of a sulphur yellow on the outside. It dissolves wholly in water, and forms a colourless solution. Heated to dull redness in a platina crucible it undergoes semi-fusion, and loses at least .35 of water without disengaging any sulphurous, or sulphuric, acid. It is composed of

| | |
|---|---|
| Peroxide of iron | .165 |
| Protoxide of iron | .085 |
| Sulphuric acid | .344 |
| Water | .406 |
| | 1.000 |

It is a mixture of the sulphate of the protoxide and the sulphate of the peroxide of iron, both neutral. It results probably from the evaporation of the solution of sulphate of iron which has remained a long time exposed to the air.

This salt was sent as having been calcined in a reverberatory furnace; but the great quantity of water it contained, gives reason to believe it was only dried in pans. Ibid.

## *Analysis of a substance employed in colouring Porcelain purple.* By M. Malagutti.

The English potters ornament their beautiful ware with designs printed in a very agreeable purple red, which they call pink colour. I found this material composed of

| | |
|---|---|
| Stannic acid | .780 |
| Lime | .150 |
| Silica | .030 to .040 |
| Alumine | .020 |
| Oxide of chrome | .005 |
| Chromate of lime, or potash | .003 |
| | .988 |

In combining, by strong calcination, 100 of stannic acid, 34 of chalk, 1 to 1½ of Oxide of chrome, or 3 to 4 of crystalized chromate of potash, we obtain a colour very similar. We may add, if we wish, 5 of silica and 1 of alumine. The mass is of a dirty red; but it becomes a beautiful rose after it has been washed with water weakly acidulated by muriatic acid.

The experiments that I have made have proved, 1st, that stannic acid is coloured by chromate of potash or by the oxide of chrome at a red heat only when lime is added; 2d, that silex and alumine, without being indispensable, enhance the colour and turn it to a violet; 3d, and that the more cime and chromate of potash or oxide of chrome we add, the deeper the colour becomes, and that it may gradually attain to a chesnut brown.

If we heat to 150° C. (= 300° F.) a mixture of 100 parts of stannic acid and 2 of oxide of chrome, we have a compound consisting of small vitreous grains of a superb lilac colour. This compound which I call *mineral lac*, resists every decomposing agent, and may be applied, not only to the colouring of paper hangings, and to pottery, but also to oil painting as a substitute for the vegetable lac which painters are obliged to use to obtain a similar colour.

The question of determining the precise condition of the chrome in the pink colour, and in the mineral lac, is a difficult one to solve. Nevertheless every thing induces me to believe it to be in the state of an oxide, and not in that of acid, in the preparation of pink colour.

The presence of lime makes up for the temperature to which we have recourse in the fabrication of mineral lac, to determine the combination of the oxide of chrome with stannic acid.

The principal considerations on which I found my opinion are the following; 1st, many of the salts of chrome are violet; chrome alum, melted in its water of crystalization, is green, but it becomes lilac if we heat it slightly red; 2d, the oxide of chrome, heated in vacuo with stannic acid and lime, gives a pink colour; 3d, stannic acid, which can be feebly coloured by the oxide of chrome at a clear red heat, is inattackable by muriatic acid, whilst pink colour, after it has been washed with acidulated water, is attacked by that acid, so that it dissolves the whole of the lime, almost the whole of the oxide of chrome, and such a proportion of the stannic acid, that it contains a neutral stannate of lime; 4th, when we calcine lime with the oxide of chrome in contact with air, chromate of lime is formed, and a combination of that earth and of the oxide of chrome, soluble in weak acids, from which it is precipitated by alkalies in the cold. Idem.

### *Analysis of a double Phosphate of Lead and Lime.* By M. Baruel.

This mineral was discovered in the mine of Nussiere, near Beaujeu, by M, Danhauser. It is sometimes in crystals, which are very obtuse rhombohedrons, almost lenticular, sometimes mamellated. Its fracture is somewhat splintery; its lustre is greasy and faint; its colour yellow, greenish, or grayish; its powder of a yellowish white. Its density is 5.0415. It rests on hyaline quartz. I have found the mamelonaceous variety to be composed of

| | | Oxygen. |
|---|---|---|
| Quartz | .0720 | |
| Chloride of lead | .0765 | |
| Oxide of lead | .4650 | .0330 |
| Lime | .1230 | .0345 |
| Protoxide of iron | .0244 | .0055 |
| Phosphoric acid | .1980 | .1110 |
| Arsenic acid | .0406 | .0141 |
| | .9995 | |

From these data it must be considered as formed of

| | | | |
|---|---|---|---|
| Mixed quartz | | .0720 | |
| Chloride of lead | (Cl. Pb) | .0765 | 1 atom. |
| Phosphate of lead | $(\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}}\ \dot{P}b^3)$ | .5640 | 7 |
| Phosphate of lime | $(\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{P}}\ \dot{C}a^3)$ | .2220 | 7 |
| Arseniate of iron | $(\overset{\cdot\cdot\cdot\cdot\cdot}{\bar{As}}\ \dot{F}e^2)$ | .0650 | 2 |

Idem.

### *On a large and very sensible Thermoscope Galvanometer.* By John Locke, M. D. *Professor of Chemistry in the Medical College of Ohio.*

The chief novelty of the instrument which I am about to describe, consists in its proportions and the resultant effects. The object which I proposed in its invention was to construct a thermoscope so large that its indications might be conspicuously seen, on the lecture table, by a numerous assembly, and at the same time so delicate as to show extremely small changes of temperature. How far I have succeeded will in some measure appear by a very popular, though not the most interesting experiment which may be performed with it. By means of the warmth of the finger applied to a single pair of bismuth and copper disks, there is transmitted a sufficient quantity of electricity to keep an eleven-inch needle, weighing an ounce and a half, in a continued revolution, the connexions and reversals being properly made at every half turn.

The greater part of this effect is due to the *massiveness* of the coil, which is made of a copper fillet about fifty feet long, one-fourth of an inch wide, and one-eighth of an inch thick, weighing between four and five pounds. This coil is not made in a pile at the diameter of the circle in which the needle is to revolve, but is spread out, the several turns lying side by side, and covering almost the whole of that circle above and below. The best idea may be formed of the coil by the manner in which it is actually modeled by the workman. It is wound closely and in parallel turns on a circular piece of board eleven and a half inches in diameter and half an inch in thickness, covering the whole of it except two small opposite segments, of about 90 degrees each. The board being extracted leaves a cavity of its own shape to be occupied by the needle.

The copper fillet is not covered by silk, or otherwise coated for insulation, but the several turns of it are separated at their ends, by veneers of wood, just so far as to prevent contact throughout. In the spreading out and compression of the coil it is similar to Melloni's elegant apparatus, though in my isolated situation in the interior of America, I was not acquainted with the structure adopted in his prior invention. In the *massiveness* of the coil my instrument is perhaps peculiar, and by this means it affords a free passage to currents of the most feeble intensity, enabling them to deflect a very heavy needle. The coil is supported on a wooden ring furnished with brass feet and leveling screws, and surrounded by a brass hoop with a flat glass top or cover, in the centre of which is inserted a brass tube for the suspension of the needle by a cocoon filament. The needle is the double astatic one of Nobili, each part being about eleven inches long, one-fourth wide, and one-fortieth in thickness. The lower part plays within the coil and the upper one above it, and the thin white dial placed upon it, thus performing the office of a conspicuous index underneath the glass.

I have not yet made any very extensive experiments with this instrument, being only just now prepared to do so. It is very sensible to a *single* pair of thermo-electric metals, to the action of which it seems peculiarly adapted; but the efficiency of such metals is increased by a repetition of the pairs, as in the thermo-pile of M. Melloni, especially if they be massive in proportion to the coil itself. With a battery of five pairs of bismuth and antimony, the needle was sensibly moved by the radiation from a person at the distance of twelve feet, without a reflector, the air being at the temperature of 72°.

In a recent interview with M. Melloni, to whose politeness I am much indebted, he expressed his opinion that with a thermo-pile massive in proportion to the coil, my galvanometer might be made to exhibit his thermo-experiments advantageously to a large class. Some idea may be formed of its fitness for this purpose from the result of a single trial on transmission. The heat from a small lamp with a reflector, at the distance of five feet, passed through a plate of alum, and falling on a battery or pile of five pairs of bismuth and antimony, deflected the needle only a fraction of one degree, but on substituting a similar plate of common salt, the same heat produced, by impulse, an immediate deflection of 33 degrees.

Although the instrument is finely adapted by its size for the purpose for which it was intended, class illustration, yet from the weight of the needle and the difficulty of bringing it to rest after it once acquires motion, it is not so suitable for experiments of research as the Mellonian galvanometer. When a massive thermo-pile, such as has lately been made by Messrs. Watkins and Hill of Charing-cross, is connected with the coil and excited by a heat of about 200°, the needle being withdrawn a distinct spark is obtained on interrupting the circuit; in producing this effect it is less efficient however than the ribbon coil of Prof. Henry. The tube for suspension, placed over the centre of the instrument, is so constructed as to admit of being turned round by means of an index, which extends from it horizontally over the glass cover, and thus any degree of torsion may be given to the suspending filament or wire. A wire of any desired thickness may be easily substituted for the cocoon filament, when the instrument becomes adapted to measuring the deflecting forces of the galvanic battery. By using a thick wire it was ascertained that the calorimotor of Professor Hare, having forty plates, each eighteen inches square, acted on the needle with a force equal to ninety-two grains, applied at the distance of six inches from the centre. In attempting to force the needle by torsion into a line parallel to the coil, where the deflecting current acts with the greatest strength, I accidentally carried it too far and reversed its *position*, when instantly it became reversed in *polarity*, that which had been the north pole becoming south. This showed how unfit is the magnetic needle to measure such a quantity of electricity as was then flowing through the massive conductor. The instrument is well adapted to show to a class the experiments upon radiant heat with Pictet's conjugate reflectors, in which the differential, or air, thermometer affords, to spectators at a distance, but an unsatisfactory indication. For this purpose, the electrical element necessary is merely a disk of bismuth as large as a shilling, soldered to a corresponding one of copper, blackened, and erected in the focus of the reflector, while conductors pass from each disk to the poles of the galvanometer. With this arrangement the heat of a non-luminous ball at the distance of twelve feet will impel the needle nearly 180°, and if the connexions and reversals are properly made will keep it in a continued revolution.

I have thus given you a brief sketch of an instrument which seems to supply a desideratum on the lecture-table, when the common thermometer is too small to afford to a class that direct and full satisfaction which, in a subject so important as that of heat, is very desirable to every professor. I have not, so far, attempted to use it extensively as an instrument of research, yet it shows evidently the importance of massiveness in conductors for feeble currents, such as those produced by thermo-combinations; nor am I certain that I have arrived at a maximum in this particular, for so far as I have proceeded in using thicker conductors for the coil, the deflecting effects have been increased.

I am, &c.

JOHN LOCKE.

London, Aug. 30, 1837.

Lond. & Edin. Philos. Mag.

## *Description of the Borax Lagoons of Tuscany.*

The borax lagoons of Tuscany are entitled to a detailed description. They are unique in Europe, if not in the world; and their produce has become an article of equal importance to Great Britain, as an import, and to Tuscany, as an export. They are spread over a surface of about thirty miles, and exhibit, from the distance, columns of vapour, more or less according to the season of the year and state of the weather, which rise in large volumes amongst the recesses of the mountains. As you approach the lagoons, the earth appears to pour out boiling water as from volcanoes of various sizes, in a variety of soil, but principally of chalk and sand. The heat in the immediate adjacency is intolerable, and you are drenched by the vapour which impregnates the atmosphere with a strong and somewhat sulphurous smell. The whole scene is one of terrible violence and confusion—the noisy outbreak of the boiling element—the rugged and agitated surface—the volumes of vapour—the impregnated atmosphere—the rush of waters among bleak and solitary mountains. The ground, which burns and shakes beneath your feet, is covered with beautiful crystalizations of sulphur and other minerals. The character beneath the surface at Mount Cerbole is that of a black marl streaked with chalk, giving it at a short distance the appearance of variegated marble. Formerly the place was regarded by the peasants as the entrance to hell, a superstition derived, no doubt, from very ancient times; for the principal lagoons and the neighboring volcano still bear the name of Monte Cerbole. *(Mons Cerberi.)* The peasantry never passed by the spot without turning their heads and praying for the protection of the virgin. The borax lagoons have been brought into their present profitable action within a very few years; scattered over an immense district, they have become the property of an active individual, M. Larderel, to whom they are a source of wealth, more valuable,perhaps,and certainly less capricious than any mine of silver that Mexico or Peru possesses. The process of manufacture is simple, and is effected by those instruments which the neighbourhood itself presents. In these spots artificial lagoons are formed by the introduction of the mountain streams. The hot vapour keeps the water continually in boiling ebullition, and after it has received its impregnation during twenty-four hours at the most elevated lagoon, the contents are allowed to descend to the second lagoon, where a second impregnation takes place, and then to the third, and so forth, till it reaches the lowest receptacle, and having thus passed through from six to eight lagoons, it has reached one half per cent. of the boracic acid. It is then transferred to the reservoirs, from whence, after a few hours rest it is conveyed to the evaporating pans, where the hot vapour concentrates the strength of the acid, by passing under shallow leaden vessels, from the boiling fountains above, which it quits at a heat of eighty degrees of Réaumur, and is discharged at a heat of sixty degrees. There are from ten to twenty pans, in each of which the concentration becomes greater at every descent, till it passes to the crystallizing vessels, from whence it is carried to the drying-rooms, when, after two or three hours, it becomes ready to pack for exportation. The number of establishments is nine. The whole amount produced varies from 7000lbs. to 8000lbs. (of twelve oz.) per day. The produce does not appear susceptible of much extension, as the whole of the water is turned to account. The atmosphere has, however, some influence on the result. In bright and clear weather, whether in winter or summer, the vapours are less dense but the depositions ol boracic acid in the lagoons are greater. Increased vapours indicate unfavourable change of weather, and the lagoons are infallible barometers to the neighbourhood, even at a great distance, serving to regulate the proceedings of the peasantry in their agricultural pursuits. It had been long supposed that the boracic acid was not to be found in the vapours of the lagoon; and when it is seen how small the proportion of acid must originally be, it will not be wondered at that its existence should have escaped attention. In the lowest of the lagoons, after five, six, and in some cases a greater number of impregnations, the quantity of boracic acid given out does not exceed one half per cent.; thus, if the produce be estimated at 7500lbs. per day, the quantity of saturated water daily discharged is 1,500,000lbs. Tuscan or 500 tons of English.

The lagoons are ordinarily excavated by the mountaineers of Lombardy, who emigrate into Tuscany during the winter season, when their native Appenines are covered with snow. They gain about one Tuscan lira per day. But the works are conducted, when in operation, by natives, all married, and who occupy houses attached to the evaporating pans. They wear a common uniform, and their health is generally good. A great improvement in the cultivation, and a great increase in the value of the neighboring soil, has naturally followed the introduction of the manufacture of the boracic acid. A rise of wages has accompanied the new demand for labour; much land has been brought into cultivation by new directions given to the streams of smaller rivers. Before the boracic lakes were turned to profitable account, their fetid smell, their frightful appearance, agitating the earth around them by ceaseless explosions of boiling water, and not less the terrors with which superstition invested them, made the lagoons themselves to be regarded as public nuisances, and gave to the surrounding country a character which alienated all attempts at improvement. Nor were the lagoons without real and positive dangers, for the loss of life was certain where man or beast had the misfortune to fall into any of those boiling baths. Cases frequently occurred in which cattle perished; and one chemist, of considerable eminence, met with a horrible death by being precipitated into one of the lagoons. Legs were not unfrequently lost by a false step into the smaller pit *(patizze)* where before the foot could be withdrawn, the flesh would be separated from the bone.

Min. Jour.

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## *Description of Mr. Henry Guy's method of giving a true spherical figure to balls of metal, glass, agate, or other hard substance. Communicated by* Bryan Donkin, Esq., V. P. Inst. C. E.

The method adopted by Mr. Guy, consists simply in applying to practice the principle, that if a ball can be made to revolve rapidly in every possible direction, or in other words, if during such revolution its axis of rotation be constantly changing its angular position within the ball itself, whilst a grinding tool is applied to the surface of the ball, the most prominent parts of that surface will be first acted on by the grinder, and by continuing the operation the whole of the high er parts of the surface will be progressively ground off, and the ball will ultimately be left of a perfect spherical shape. Mr. Guy effects this by placing the ball betwixt the faces of two wooden chucks fixed to two lathe mandrels, such as are used in common turning lathes with their axes exactly in a line with each other. A quick motion is given to the mandrels in the usual way by two bands, so applied that the mandrels are placed in opposite directions; the ball, being compressed betwixt the chucks; turns, notwithstanding the friction of the tool. The tool is a bar of brass or iron, with a conical hole near one end, the larger diameter of which is made a little larger than the diameter of the ball.

Jour. of Arts and Sciences.

### *Whishaw's Hydraulic Telegraph.*

We have long ago heard it suggested, and we think by Mr. Vallance, that a column of water could be conveniently employed to transmit information. Mr. Francis Whishaw has conveyed a column of water through sixty yards of pipe in the most convoluted form, and the two ends of the column being on a level, motion is no sooner given to one end than it is communicated through the whole sixty yards to the other end of the column. No preceptible interval elapses between the time of impressing motion on one end of the column and of communicating it to the other. To each end of a column he attaches a float board with an index, and the depression of any given number of figures on one index, will be immediately followed by a corresponding rise of the float board and index at the other end. It is supposed that this simple longitudinal motion can be made to convey all kinds of information. It appears to us that the amount of information which can be conveyed by the motion in one direction only, of the water, or backward and forwards, must be limited. To make the mere motion backwards and forwards of a float board, indicated on a graduated index, convey a great number of words or letters, is the difficulty to be overcome. Mr. Whishaw has exerted his ingenuity in this way, with a promise of success, and by-and-bye, the hydraulic telegraph may supersede the semaphore and the galvanic telegraph.—*Courier.* Lond. Mech. Mag.

### *Incombustible Thatch.*

This is a subject which I look upon as highly important to the "rural population" of this, and every other country, where houses, barns, and other buildings are so often covered with straw or thatch.

It is announced, that a Mr. G. B. Barentin, of Leipsic, has invented a method of rendering the thatching of buildings fire-proof. Alum, as is justly observed, will render all vegetable tissues, or fibres, incombustible; that is, its application in solution will prevent their burning in a flame. Any one may prove this with a piece of sheet or old cotton handkerchief. But then the alum being soluble, the rain will wash it out, and carry off the preserving substance, perhaps the day after its application.

A sure and cheap method of rendering straw thatch incombustible, which I have experimented upon and proved, to my entire satisfaction, is to saturate the thatch once with a solution of lime in water, or with what is commonly used as whitewash. The addition of one pound of alum to every five gallons of whitewash, will greatly improve the composition, and it will remain in the pellicle of lime which covers every straw, so as never to be washed out by the rain. I have poured a bucket of whitewash over a heap of dry furze, then kept it in the July sun until as dry as possible, and then (let any man try it) it will not burn, even aided by ten pair of bellows.

When any building is being thatched, what more easy and cheap than to keep paying the straw with such whitewash? It will also prevent corruption, and cause the thatch to last incomparably longer than that of clean straw. Of course, the solution of lime should have the addition of a little size. The lime, size, and alum will form a crust insoluble in water, protecting each straw to which it adheres. Of course, the straw next the house must be protected as well as the exterior.

I wonder how any family can sleep quietly under a roof that may be set in a blaze by a spark from a chimney, or from a pipe, or a cigar, or a flash of lightning! We almost daily hear of people being burnt out of their cottages in Ireland, by the thatch being ignited. I hope your readers will think of this preservative, try it, and promulgate its importance. I have the honour to be, Sir, your obedient servant,

FRANCIS MACERONI.

Ibid.

## Progress of Physical Science.

### *On the Formation of Mould, by* CHARLES DARWIN, Esq., F. G. S.

The author commenced by remarking on two of the most striking characters by which the superficial layer of earth, or, as it is commonly called, vegetable mould, is distinguished. These are its nearly homogeneous nature, although overlying different kinds of subsoil, and the uniform fineness of its particles. The latter fact may be well observed in any gravelly country, where, although in a ploughed field, a large proportion of the soil consists of small stones, yet in old pasture-land not a single pebble will be found within some inches of the surface. The author's attention was called to this subject by Mr. Wedgwood, of Maer Hall, in Staffordshire, who showed him several fields, some of which, a few years before, had been covered with lime, and others with burnt marl and cinders. These substances, in every case, are now buried to the depth of some inches beneath the turf. Three fields were examined with care. The first consisted of good pasture land, which had been limed, without having been ploughed, about twelve years and a half before: the turf was about half an inch thick; and two inches and a half beneath it was a layer, or row, of small aggregated lumps of the lime forming, at an equal depth, a well-marked white line. The soil beneath this was of a gravelly nature, and differed very considerably from the mould nearer the surface. About three years since cinders were likewise spread on this field. These are now buried at the depth of one inch, forming a line of black spots parallel to, and above, the white layer of lime. Some other cinders, which had been scattered in another part of the same field, were either still lying on the surface, or entangled in the roots of the grass. The second field examined was remarkable only from the cinders being now buried in a layer, nearly an inch thick, three inches beneath the surface. This layer was in parts so continuous, that the superficial mould was only attached to the subsoil of red clay by the longer roots of the grass.

The history of the third field is more complete. Previously to fifteen years since it was waste land; but at that time it was drained, harrowed, ploughed, and well covered with burnt marl and cinders. It has not since been disturbed, and now supports a tolerably good pasture. The section here was, turf half an inch, mould two inches and a half, a layer one and a half inch thick, composed of fragments of burnt marl (conspicuous from their bright red colour, and some of considerable size, namely, one inch, by a half broad, and a quarter thick,) of cinders, and a few quartz pebbles mingled with earth; lastly, about four inches and a half beneath the surface was the original, black, peaty soil. Thus beneath a layer (nearly four inches thick) of fine particles of earth, mixed with some vegetable matter, those substances now occurred, which, fifteen years before, had been spread on the *surface.* Mr. Darwin stated that the appearance in all cases was as if the fragments had, as the farmers believe, worked themselves down. It does not, however, appear at all possible, that either the powdered lime or the fragments of burnt marl and the pebbles could sink through compact earth to some inches beneath the surface and still remain in a continuous layer. Nor is it probable that the decay of the grass, although adding to the surface some of the constituent parts of the mould, should separate, in so short a time, the fine from the coarse earth, and accumulate the former on those objects which so lately were strewed on the surface. Mr. Darwin also remarked, that near towns, in fields which did not appear to have been ploughed, he had often been surprised by finding pieces of pottery and bones some inches below the turf. In a similar manner on the mountains of Chili he had been perplexed by noticing elevated marine shells, covered by earth, in situations where rain could not have washed it on them.

The explanation of these circumstances, which occurred to Mr. Wedgwood, although it may, at first, appear trivial, the author did not doubt is the correct one, namely, that the whole is due to the digestive process, by which the common earth-worm is supported. On carefully examining between the blades of grass in the fields above described, the author found, that there was scarcely a space of two inches square without a little heap of the cylindrical castings of worms. It is well known that worms swallow earthy matter, and that having separated the serviceable portion, they eject at the mouth of their burrows, the remainder in little intestine-shaped heaps. The worm is unable to swallow coarse particles, and as it would naturally avoid pure lime, the fine earth lying beneath either the cinders and burnt marl, or the powdered lime, would, by a slow process, be removed, and thrown up to the surface. This supposition is not imaginary, for in the field in which cinders had been spread out only half a year before, Mr. Darwin actually saw the castings of the worms heaped on the smaller fragments. Nor is the agency so trivial as it, at first, might be thought; the great number of earth-worms (as every one must be aware, who has ever dug in a grass-field) making up for the insignificant quantity of work each performs.

On the above hypothesis, the great advantage of old pasture land, which farmers are always particularly averse from breaking up, is explained; for the worms must require a considerable length of time to prepare a thick stratum of mould, by thoroughly mingling the original constituent parts of the soil, as well as the manures added by man. In the peaty field, in fifteen years, about three inches and a half had been well digested. It is probable, however, that the process is continued, though at a slow rate, to a much greater depth; for as often as a worm is compelled by dry weather, or any other cause, to descend deep, it must bring to the surface, when it empties the contents of its body, a few particles of earth. The author observed, that the digestive process of animals is a geological power which acts in another sphere on a greater scale. In recent coral formations, the quantity of stone converted into the most impalpable mud, by the excavations of boring shells and of nereidous animals, is very great. Numerous large fishes (of the genus *Sparus*) likewise subsist by browsing on the living branches of coral. Mr. Darwin believes, that a large portion of the chalk of Europe was produced from coral, by the digestive action of marine animals, in the same manner as mould has been prepared by the earth-worm on disintegrated rock. The author concluded by remarking, that it is probable that every particle of earth in old pasture land has passed through the intestines of worms, and hence, that in some senses, the term "animal mould" would be more appropriate than "vegetable mould." The agriculturist in ploughing the ground follows a method strictly natural; and he only imitates in a rude manner, without being able either to bury the pebbles or to sift the fine from the coarse soil, the work which nature is daily performing by the agency of the earth-worm.*

Lond. & Edin. Philos. Mag.

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## *Report to the Royal Geographical Society, of an expedition in the interior of Africa.*

A very full meeting of members was held on Monday evening, for the purpose of hearing the report of Captain Alexander, of his late expedition in the interior of Central Africa, directed towards the north-west coast, and the Damhara country. This expedition, originating with the society, by whom the expenses were paid, with the assistance of a grant from government, was delayed some time, till the termination of the Caffre war; but in September, 1836, Captain Alexander started on his journey, from which he returned home to the Cape on the 20th

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* Since the paper was read, Mr. Darwin has received from Staffordshire the two following statements:—1. In the spring of 1835 a boggy field was so thickly covered with sand that the surface appeared of a red colour; but the sand is now overlaid by three-quarters of an inch of soil. 2. About eighty years ago a field was manured with marl; and it has been since ploughed, but it is not known at what exact period. An imperfect layer of the marl now exists at a depth, very carefully measured from the surface, of twelve inches in some places, and fourteen in others, the difference corresponding to the top and hollows of the ridges or butts. It is certain that the marl was buried before the field was ploughed, because the fragments are not scattered through the soil, but constitute a layer, which is horizontal, and therefore not parallel to the undulations of the ploughed surface. No plough, moreover, could reach the marl in its present position, as the furrows in this neighbourhood are never more than eight inches in depth. In the above paper it is shown, that three inches and a half of mould had been accumulated in fifteen years; and in this case, within eighty years (that is, on the supposition, rendered probable from the agricultural state of this part of the country, that the field had never before been marled) the earthworms have covered the marl with a bed of earth averaging thirteen inches in thickness.

September, 1837. During this period, he had traversed an extent of 4000 miles, of which 2000 was by walking, 1000 by horses, and 1000 on the backs of oxen. With the exception of four or five German missionaries, the whole country was new to Europeans for the distance of upwards of 1000 miles. Although the zoology of South Africa is very well known, Mr. Ogilby has recognised in the collection of mammalia, made by the expedition, many new species; some fine new species were contained amongst the birds; and the *hortus siccus*, placed in the hands of Dr. Lindley, contained several new and interesting species of plants, the seeds of many of which had been sown in the gardens of the Horticultural Society. The paper was replete with the most interesting details relative to the journey, many of which were highly complimentary to missionary exertion in advancing the cause of Christianity and civilization, through the means of the missionaries, whose services were on many occasions highly advantageous to the expedition. The tribes visited were the Namacquas, Bushmen, and two great nations of the plain and hill of Damharas, all of whom showed a friendly spirit to the members of the expedition, and exhibited a wish for further intercourse with Europeans. The two latter are negroes, partaking of all their marked characters, and beyond them resides a nation of red men, whom, however, it was found impossible to visit, on account of a war which was raging between the Damharas. From a female belonging to the hill of Damharas, he purchased, for two cotton handkerchiefs and two strings of beads, a little boy about seven years of age, who was in a half-starved condition, and employed in hunting lizards for food; and the appearance of this singular juvenile native in the room, along with a great variety of their domestic and warlike implements, excited considerable curiosity and attention. At different periods, the expedition suffered much for want of water, of which they were, at one period, destitute for nearly three days, with the thermometer upwards of 100 degrees in the shade, and losing several of their oxen, sheep, and dogs; and at one time ran so short of food, at to be compelled to eat leather. On the coast, they also discovered several points affording good accommodation for vessels, and through which, a beneficial intercourse might be carried on with the interior. Near the mouth of the Orange river, he discovered large quantities of copper ore, a sample of which had been analysed by Sir John Herschel, at the Cape, and found to contain 75 per cent. of copper, which was also easily accessible, and might either be smelted with Orange river wood, or carried up the river on rafts. The whole of this interesting statement will be published in the next number of the society's "Transactions." Mining Rev.

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## *Geology of Bretagne.*

A remarkably accurate and detailed memoir has been sent to the French Academy of Sciences, by M. Paillette, concerning the geology of the western part of the province of Bretagne. This gentleman, having held an official situation in the mines of Poullaouën and Huelgoat, has profited by the opportunities thus afforded him to a great extent, and given the most exact mineral topography of several cantons of complicated structure, with a fidelity and patience which will prove of much benefit to science. Besides the memoir, there are four excellent geological maps, laid down with the utmost precision, and one of the conclusions to which M. Paillette has been led is, that all rocks of igneous origin have accidentally modified the sedimentary soils, according to circumstances which are unknown. The modifications produced by granite are a crystalline appearance, a development of the characteristics of talc, and the formation of garnets, staurotides; and those occasioned by porphyry are generally simple induration, sonorousness, and feldspathic injections. To this memoir M. Paillette has added a series of the most ingenious experiments, by which he wishes to prove the agency of electro-chemical phenomena in the daily formation of minerals in the different veins of Bretagne, and the Academy have requested him to continue his observations, in the full persuasion that they may lead to good results.

Mining Journal.

### *Singular Discovery of a Subterranean River.*

A singular discovery was made in Blaen-y-nant lead mines, near Mold, Flintshire, a few days ago. The workmen at the end of one of the levels were surprised, and obliged to run for their lives, in consequence of an immense rush of water suddenly bursting in upon them. After three days the water totally disappeared; and, on cautiously proceeding to the place, they found an opening of about four inches diameter, through which the water had issued. Hearing a sound as of a heavy run ot water inside, they enlarged the aperture so as to admit of their passing through, and found that it was the bed of a subterraneous river, which in all probability affords the principal supply to the far-famed St. Winifred's Well, at Holywell, from which it is distant about twelve miles. The stream being then shallow, they explored it about sixty yards down, and were astonished to find several large caverns to the right and left, from the roofs and sides of which were suspended numerous and beautiful specimens of white spar or stalactites. The company are in high spirits, these appearances being considered favourable for a large lodgment of ore.—*Shrewsbury Chronicle.* Ibid.

### *Mechanism of the Motion of Glaciers.*

Mr. Mallet, at the British Association, made it evident that many phenomena of these singular masses had been hitherto overlooked; and although described by many eminent observers, no solution had been given to the question of their movement but that of their weight, which he showed could have only a partial operation, as they often rest on rugged beds, and these not always of much inclination. He proposed a very ingenious explanation of their movement by means of hydrostatic pressure, arising from the fact of the lower part of the glacier being of a higher temperature than the upper: this causes a melting of the under part, and a consequent raising of the mass in a perpendicular direction to the earth's surface, while its descent was at right angles to the inclined surface: a progressive motion downwards ensues, following the law of the resolution of forces. He then spoke of certain causes of the rents and fissures in glaeiers, these being often convex downwards, owing to the operation taking place in the middle part of the mass, which descends soonest, while the whole is held in its place by the upper and lower extremities: also tubular fissures are formed by blocks of stone sinking by degrees in the glacier, owing to their higher temperature gradually melting the surrounding ice. He then alluded to the singular accumulations of detritus on the glaciers, which are locally termed *moraine*, and are formed by *éboulemens* in winter and covered by the snow. These he found to assume linear directions parallel to the axis of the glacier; and, from the regularity of their arrangements, he conceived it possible to discover the site of old glaciers from the moraine which had remained ou the ground after their destruction. Analyst.

### *On the Floating Masses of Fucus occurring near the Cape Verd Islands.*

M. Kunth lately presented to the Academy of Sciences of Paris, in the name of M. Meyen of Berlin, a specimen of the *Sargassum natans* (Fucus natans, Linn.) brought from the celebrated *Mar de Sargasso*, near the Cape Verd Islands. M. Kunth remarked, that this individual, like all the others observed by M. Meyen in these latitudes, does not present the slightest trace of a point of attachment. It was therefore never attached to rocks or to any other supporting body at any period of its growth, but must have been developed floating on the surface of the sea. The opinion generally adopted by voyagers, that these plants have been torn from their original situations by the waves, and collected by currents in the Mar de Saragasso, appears to M. Meyen to be inadmissible; and he is inclined to believe that they have been produced at the place where they are observed. The same naturalist maintains that such individuals formed at the surface of the water never exhibit fructification. Edin. New Philos. Jour.

## **Mechanics' Register.**

### *Girard College for Orphans.*

As this is an Institution in which mechanics have a deep interest, and one to the completion of which all must look forward with great anxiety, the following description of the main building and of the state of the works at the present time, by the able architect, Thomas U. Walter, Esq. cannot fail to be acceptable to our readers. Com. Pub.

### *Description of the main Building of the Girard College for Orphans.*

*By* Thomas U. Walter, *Architect.*

The Girard College is situated about one and a half miles northwest of the centre of the City, on a tract of land containing forty-five acres; the whole of which was appropriated by Mr. Girard exclusively to the purposes of the institution.

The main building, which is the subject of this description, is composed in the Corinthian order of Grecian architecture; it covers a space of 184 by 243 feet, and consists of an *octastyle*, peripteral superstructure resting upon a basement of eight feet in height composed entirely of steps extending around the whole edifice; by which a pyramidal appearance is given to the substruction, and a means of approach to the porticoes afforded from every side. The dimensions of the stylobate (or platform on which the columns stand,) are 159 feet on the fronts by 217 feet on the flanks, and the cell, or body of the building, measures 111 feet by 169 feet 2 inches. The whole height, from the ground to the apex of the roof, is 100 feet.

The columns are thirty-four in number; the diameter of the shaft at the top of the base is six feet, and at the bottom of the capital five feet; the height of the capital is eight feet six inches, and its width, from the extreme corners of the abacus, nine feet; the whole height of the column, including capital and base, is fifty-five feet.

The entablature is sixteen feet three inches high, and the greatest projection of the cornice, from the face of the frieze, is four feet nine inches; the elevation of the pediment is twenty feet five inches, being one-ninth of the span.

The capitals of the columns are proportioned from those of the Monument of Lysicrates at Athens; they are divided in height into four courses,—the first embraces the water leaf, and consists of a single stone of seventeen inches in thickness;—the second course is also composed of a single stone, the height of which is two feet ten inches,—the annular row of acanthus leaves occupies the whole of this course;—the third division of the capital embraces the volutes and cauliculi,—this course, which is likewise two feet ten inches in height, is composed of two pieces, having the vertical joint between the cauliculi on two opposite faces;—the fourth, or upper course, being the abacus, is one foot five inches in height.

The ceiling of the portico will be formed by beams resting on the tenia, and extending from the cell of the building to the colonnade opposite to each column; the spaces between the beams will be filled in with rich lacunaria.

The corners of the building are finished with massive antæ, having bases and capitals composed upon the principles of Grecian architecture.

The flanks of the cell are pierced with windows, which are ornamented with the Greek antæ, surmounted with architraves and cornices.

The doors of entrance are in the centre of the north and south fronts; they are each sixteen feet wide in the clear by thirty-two feet high; their outside finish consists of antepagmenta, of two feet seven inches wide, the supercilium of which is surmounted with a frieze and cornice;—the cornice is supported by rich consoles, of six and a half feet in height, and the cymatium is ornamented with sculptured honeysuckles.

The exterior of the whole structure will be composed of fine white marble, slightly tinted with blue.

The vestibules, which are approached by means of the doors at each end of the building, are ornamented with marble antæ, columns, and entablature, of the Greek Ionic order, which support a vaulted ceiling, consisting of eliptical groin arches, enriched with frets, guilloches, and lucunaria; the columns, which are sixteen in number, will each be composed of a single piece of marble;—proportions of the order are from the Temple on the Illusus at Athens.

The lobbies in the second story are directly over the vestibules, and occupy the same space. The columns in this story, which are also sixteen in number, will be composed in the simplest form of Corinthian, or foliated, architecture, proportioned from those of the Tower of Andronicus Cyrrhestes at Athens; the entablature will be surmounted with groin arches, similar to those in the vestibules, the soffits of which will be enriched with lacunaria.

The stairways will all be composed of marble; they will be constructed in the four corners of the building, each occupying a space of twenty-two by twenty-six feet, extending the whole height of the edifice; these openings will each be crowned with a pendentive parabolic dome, surmounted with a skylight of ten feet in diameter—the height of the skylight from the floor will be eighty feet.

The building is three stories in height; each of which is twenty-five feet from floor to floor: there are four rooms of fifty feet square in each story. Those of the first and second stories, are vaulted with groin arches; and those of the third story, with domes supported on pendentives, which spring from the corners of the rooms at the floor, and assume the form of a circle on the horizontal section at the height of nineteen feet. These rooms are lighted by means of skylights of sixteen feet in diameter. All the domes are terminated below the plane of the roof, and skylights are designed to project but one foot above it, so as not to interfere with the character of the architecture.

The whole building will be warmed by means of furnaces, placed in the cellar; and every apartment will be ventilated upon philosophical principles.

### *Report of the Present state of the Work.*

The marble work of the cell of the centre building has been raised about ten feet during the past year, making its present height above the ground about sixty feet.

All the bands and ties for resisting the lateral pressure of the arches over the second story rooms, are firmly fixed in the walls, and the centres are completed, and prepared to receive the brick work—all therefore that remains to be done to complete this story, is simply the construction of these arches, and the setting of the marble in the lobbies, which will consequently be the first work of the ensuing season.

We had expected to finish all the second story arches during the past summer; but the unusual severity of the previous winter, and the backwardness of the spring, put it out of our power to advance with this part of the work so rapidly as we had anticipated. We have, however, been actively employed on other parts of the buildings; having accomplished, in the aggregate, at least one-third more during the past year, than in any previous season since the commencement of the work.

The easternmost *out building* is now under roof, and the carpenters are engaged in finishing the interior.

The out building nearest the college requires about ten feet in height of marble work to complete the exterior, the greater part of which will be wrought during the winter, so as to enable us to put this building under roof early in the ensuing season:—both of these out buildings will be completed during the present year, and may be occupied as soon as they are finished, without interfering with the rest of the work.

At the commencement of the last season, there were *four hundred and thirty thousand bricks* remaining on the ground from the previous year; since which time, there have been delivered at the works, one million five hundred and ninety thousand, making in all, two millions and twenty thousand; of which *one million five hundred and twenty thousand* have been used in the buildings, leaving about *five hundred thousand bricks* now on the ground to commence operations with in the spring.

The amount of marble work done during the past season is almost double that of any previous year; and the character of the workmanship still merits the highest commendation.

The execution of the carving of the exterior capitals continues to give entire satisfaction.

Several of the large bases and column blocks are now in the hands of the workmen; and it is intended to continue with this part of the work during the winter, so as to enable us to proceed at the opening of the ensuing season, with the eastern portico, the two south columns of which have already been commenced.

The columns, antæ and entablature for the lobbies in the second story are in progress of execution; there are now completed, for this part of the work, ten capitals, fourteen bases, seven shafts of columns, and a considerable quantity of the architrave and antæ; the rest will be finished in the course of three or four months.

All the marble used in the buildings during the past year, amounts to 40,588 superficial feet, and there are now on the ground 12,338 feet of finished work, 2,173 feet of sawed material, and 3,950 cubic feet in the rough.

It is a source of great satisfaction to be able to state, that all our apprehensions in regard to the supply of marble are relieved, as the contractors have begun to work another quarry, which will enable us to obtain, without difficulty, all that may be required for the completion of the college, and all the buildings connected with it.

The whole amount of marble delivered during the past year, amounts to 39,722 cubic feet;—more than one hundred column blocks have already been quarried, and all that will be required for the exterior portico can be procured, if necessary, during the ensuing season.

The expenditures, from December 23, 1835, to December 31, 1836, amount to $153,949 74.

I have estimated the value of the materials and workmanship now on the ground, which have not yet been used in the building, at about $68,000, nearly all of which will be used during the present year.

I am happy to have it in my power to say, that thus far nothing has been omitted that would tend to give permanency and durability to the buildings;—the plans have been correctly executed, and the various departments of the work have all been faithfully and judiciously managed, by the gentlemen whom you have appointed over the several mechanical branches.

The propriety of commencing the two western out buildings in the spring, is a subject to which I would respectfully request your early consideration;—the foundations of these buildings may be laid, and the marble work constructed as high as the basement during the ensuing season, without interfering with the other work; I therefore venture to suggest, that arrangements be made for extending the work, so as to embrace these two buildings.

*Girard College,* THOMAS U. WALTER,
*January 2nd.* 1837. *Architect.*

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## *Paving Streets with Wood.*

At a meeting of the Marylebone Vestry, held Aug. 26, 1837, "Mr. Stead was introduced to the Vestry to state his plan for paving Oxford Street with wood. He said that the plan had been approved of by Sir

George Rennie, Mr. G. Rennie, Mr. Gibbs, Mr. Braithwaite and other engineers, and that they had expressed their surprise that it had not been adopted in London. It had been found to answer exceedingly well in St. Petersburg and New York, and possessed great advantages over the usual mode of paving, inasmuch as the cost would be less, the durability greater, and it would be unaccompanied by the noise which the present system is of necessity subjected to. The plan had been seen in operation in the Netherlands by Mr. Rennie, who highly approved of it. Mr. Stead was requested to furnish the Vestry with a written statement of his plan, which he consented to do."—(*Morn. Chron.*, Aug. 28.) It appears that this mode of paving has been tried for about a year and a half past in the Broadway, New York, and found to answer very well. The wood employed was that of the Robín*ia* Pseùd-Acàcia, cut into hexagonal pieces, about 1 foot long and 10 inches across. Another experiment is now being made, with square pieces of pine and other woods, with boards placed under them, where the ground is not firm. —(*Newsp.*) Architec. Mag.

We may add to this statement that Chesnut street, Philadelphia, from Fourth to Fifth street (now ycleped Bank Place) has been paved in excellent style, with polygona. G.

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### *The Steam Ship Sea Horse.*

We have been gratified with a view of, and trip on board, the beautiful and powerful steam ship *Seahorse*, which arrived here, on Wednesday, from Dundee, after a run of twenty-five hours, against a strong head wind. On going on board, the visitor is struck with the spacious deck and splendid saloon, as well as the general fittings and arrangements both for comfort and safety. But that which most strongly attracts the attention of the scientific observer, is the beautiful manner in which the engines perform their functions; indeed the motion is so perfectly smooth, that if you were not aware of the fact, you would scarcely believe that the engines were at work. The reason why these engines are superior to the generality of marine engines, is the application of Mr. Samuel Hall's patent condensers, and as many persons may not be acquainted with the nature and merits of Mr. Hall's invention, it may not be amiss to give a few particulars on this point, particularly as it bears so much on the safety of the boilers, and the wear and tear of the engines. First: the boilers are supplied with pure distilled water, which prevents the usual saline deposit and corrosion of the boiler. Second: as no deposit or incrustation can possibly take place, the transmission of heat to the water is more uniform, the boiler-plates are prevented from burning, and consequently a saving of fuel is the result. Third: as the steam is condensed through the medium of copper pipes (the steam being prevented from coming in contact with the jet of cold water, as in the common mode,) the air-pump has less work to perform, and additional power is thereby gained. Fourth: muddy salt water is entirely shut out from the interior of the engine, and an immense saving is effected in the wear and tear of the moving parts, as the valves, &c.; and from the muddy quality of the river Humber, it is an invaluable discovery for steamers connected with Hull. In conclusion we have but one regret, which is, that from the great width of the *Seahorse*, she will not be able to enter any of the docks, being many feet wider than any of the dock locks, but trust that the dock company will not be long before they see the necessity of giving increased accommodation.—*Hull Advertiser.*

Mining Journal.

### *Steam Engines within the Borough of Birmingham:*

By a report made to the Birmingham Philosophical Institution, October, 1836, it appears that 169 steam-engines had been erected from 1780 to that period, of which 17 had been erected in 1834, and 22 in 1835. The total horse power was equal to 2700 horses. Within the same period engines equal to 162 horses' power had become void, or removed. Of those erected and estimated in horse power, 275 were used for grinding flour; 1770 for working metals; 279 for pumping water; 87 for glass grinding; 97 for working wood; 44 for paper making and glazing; 37 for grinding clay; 61 for grinding colours and chemicals; and 50 for sundry purposes. The estimated consumption of coals is 216 tons per day; estimated number of persons employed 4000 males, and 1300 females; and the estimated amount of power hired out, equal to 450 horses. These estimates are confined to engines within the borough, and, of course, do not include the great Soho works of Bolton and Watt. Of the 1770 horse power employed in working metals, it is computed that 162 is used by iron founders, first applied in 1788; 570 in rolling copper, brass, and other metals, first applied in 1790; 150 in drawing wire, first applied in 1808; 201 in iron forges, and wrought iron mills, first applied in 1810; 74 in nail cutting, first applied in 1813; 104 in screw making, first applied in 1819; and 34 in drawing metal tubes, first applied in 1822.—*Railway Mag.*

ibid.

### *Preservation of Wood from Decay.*

The wood which is used in the salt mines of Hallein, in Germany, is preserved from decay by being saturated in strong brine. This discovery was made by observing, that the timber which supports the ceiling of the galleries, upon being exposed to the action of the salt earth, became harder and harder, and scarcely ever after liable to decay. From this fact it is supposed that the *bichloride of sodium* is as efficacious in preserving vegetable matter from the destroying energies of the dry-rot, as the *bichloride of mercury*. Certain it is, that the former plan is preferable, to the latter, so far as it is free from the injurious powers which the mercury presents to the workman, when the article which is so prepared is used in manufactories. The former is well worthy of trial, and if found to possess the qualities which it is presumed it contains, its economy and simplicity will place it within the reach of every individual.

Ibid.

### *Post Office Revenue of England.*

A return prepared for the House of Lords, on motion of the Duke of Richmond:—shews that there has been a gradual increase from 1827 to 1836.

| | Gross Revenue. | Net Revenue. |
|---|---|---|
| In 1827 the amount was | £2,278,412 | £1,484,164. |
| 1836 “ “ “ | 2,461,805 | 1,645,835. |

ibid.

## LUNAR OCCULTATIONS FOR PHILADELPHIA, JULY 1838.

Angles reckoned to the right or westward round the circle, as seen in an inverting telescope.
☞ For direct vision add 180° ☜

| Day. | H'r. | Min. | Star's name. | Mag. | from Moon's North point. | from Moon's Vertex. |
|---|---|---|---|---|---|---|
| 3 | 12 | 40 | Im. A' Scorpii | ,5, | 17° | 62° |
| 3 | 14 | 9 | Em. | | 325 | 13 |
| 7 | 11 | 8 | Im. 58 ω Sagittarii | ,6, | 126 | 107 |
| 7 | 12 | 22 | Em. | | 263 | 258 |
| 7 | 13 | 16 | Im. 60 α Sagittarii | ,5,6, | 161 | 164 |
| 7 | 14 | 6 | Em. | | 238 | 250 |
| 15 | 14 | 23 | Im. ζ Arietis | ,5, | 163 | 109 |
| 15 | 15 | 5 | Em. | | 254 | 199 |

## *Meteorological Observations for January* 1838.

| Moon. | Days. | Therm. | | Barometer, | | Wind. | | Water fallen in rain. | State of the weather, and Remarks. |
|---|---|---|---|---|---|---|---|---|---|
| | | Sun rise. | 2 P.M. | Sun rise. | 2 P.M. | Direction. | Force. | | |
| | | | | Inch's | Inch's | | | Inches. | |
| | 1 | 33 | 42 | 30.13 | 30.30 | E. | Moderate. | | Cloudy—clear. |
| ☾ | 2 | 30 | 35 | 20 | 20 | W. | do. | | Cloudy—do. |
| | 3 | 34 | 45 | 10 | 15 | S.W. | do. | | Cloudy—lightly cloudy. |
| | 4 | 36 | 55 | 5 | 6 | S. | do. | | Clear—do. |
| | 5 | 46 | 62 | 29.85 | 29.80 | S. | Brisk. | | Partially cloudy—cloudy. |
| | 6 | 39 | 48 | 30.10 | 30.25 | W. | Moderate. | | Clear—do. |
| | 7 | 32 | 53 | 10 | 29.96 | NW.S. | do. | | Clear—lightly clooudy. |
| | 8 | 49 | 38 | 29.74 | 90 | SW. | do. | .05 | Cloudy—rain. |
| | 9 | 29 | 33 | 63 | 60 | E. | do. | .03 | Cloudy—drizzle. |
| ☺ | 10 | 28 | 32 | 30.00 | 30.00 | W. | do | | Clear—do. |
| | 11 | 17 | 21 | 23 | 23 | NW. | do. | | Clear—do. |
| | 12 | 19 | 33 | 35 | 35 | W | do. | | Clear—do. |
| | 13 | 29 | 42 | 25 | 25 | W.S. | do. | | Clear—do. |
| | 14 | 29 | 46 | 29.93 | 29.93 | S. | do. | .05 | Partially cloudy—rain. |
| | 15 | 42 | 43 | 63 | 75 | W. | Brisk. | | Partially cloudy—do. do. |
| | 16 | 28 | 50 | 30.00 | 30.00 | SW. | Moderate. | | Clear—do. |
| | 17 | 43 | 55 | 84 | 29.85 | SW.S. | Brisk. | | Partially cloudy—do. do. |
| ☽ | 18 | 48 | 60 | 85 | 85 | SW. | Moderate. | | Heavy fog—lightly cloudy. |
| | 19 | 48 | 43 | 50 | 40 | SW.W. | Brisk. | | Cloudy—do. |
| | 20 | 23 | 32 | 30.10 | 30.15 | W. | Moderate. | | Clear—do. |
| | 21 | 24 | 29 | 10 | 5 | W. | do. | | Cloudy—do. |
| | 22 | 20 | 30 | 20 | 20 | NE.E. | do. | | Partially cloudy—clear. |
| | 23 | 20 | 37 | 20 | 20 | NE. | do. | | Clear—do. |
| | 24 | 24 | 43 | 15 | 20 | E.S. | do. | | Clear—do. |
| ⊗ | 25 | 36 | 40 | 20 | 20 | E. | do. | | Clear—do. |
| | 26 | 42 | 47 | 29.85 | 29.85 | SW.W. | do. | .43 | Rain—clear. |
| | 27 | 36 | 38 | 30. 5 | 90 | NE.SE. | do. | .42 | Cloudy—rain. |
| | 28 | 36 | 42 | 29-50 | 50 | W. | Blustering. | | Cloudy—flying clouds. |
| | 29 | 23 | 28 | 85 | 80 | W. | do. | | Partially cloudy—do. do. |
| | 30 | 16 | 23 | 30.00 | 30.00 | W. | Moderate. | | Clear—flying clouds. |
| | 31 | 12 | 23 | 16 | 16 | W. | do. | | Clear—do. |
| | Mean | 31.32 | 40.26 | 30.00 | 30.00 | | | .98 | |

| | Thermometer. | Barometer. |
|---|---|---|
| Maximum height during the month. | 62.00 on 5th. | 30.35 on 12th, |
| Minimum do. | 12.00 on 31st. | 29.40 on 19th. |
| Mean do. | 35.78 | 30 |

# JOURNAL

OF THE

# FRANKLIN INSTITUTE

OF THE

State of Pennsylvania,

AND

# MECHANICS' REGISTER.

JUNE, 1838.

## Practical and Theoretical Mechanics and Chemistry.

### *Some researches as to Lime and Mortars. By* M. Courtois, *Engineer of Roads and Bridges.** *(From the Annales des Ponts et Chaussées, Paris,* 1834.) *Translated from the French by J. G. Totten, Lt. Col. of Eng. and Brevet Col. United States Army.*

(Continued from page 321.)

The art of making good mortars is every day becoming better appreciated, from the influence it exercises in the economy and on the duration of constructions. If, in every great work, the constructors would make known the researches they have instituted, and the conclusions to which they have been led, we should soon know the resources presented by each locality, and be every where able, progressively, to improve the manufacture of mortars.

Having had occasion at various times to make numerous essays on lime and hydraulic mortars, and on the means of making them economically, I think I am fulfilling a duty in presenting a summary of the principal results.

My investigations have had particularly in view the qualities of the mixtures, or combinations of lime and clay, comprised between hydraulic lime and cement; but in order not to leave any void in the scale of various proportions to be tried, I thought it best to try all combinations possible with 100 parts of the mixture.

I shall examine successively,

1st. The elements of these combinations, viz. limestones, clayey earth, and marl; I shall give the analysis of each, and examine their respective properties.

2nd. The combinations made with the most simple proportions, and which, for greater clearness in the tables, I shall call combinations of the first order: these will be mixtures of 1, 2, 3, 4, &c., parts of clay, with 9, 8, 7, 6, &c., parts of lime.

3rd. The combinations of the second order, or hydraulic pastes, resulting from the preceding compounds, mixed, in their turn, with various proportions of fat lime.

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*The object of these researches was to give to fat lime the hydraulic quality necessary, and to mortars a determinate resistance, at a small expense.

4th. Combinations of the third order, or mortars resulting from the mixture of the preceding hydraulic pastes with twice their volume of sand.

I shall give, moreover, the experiments made with each hydraulic paste, and each mortar, to determine the hardness, after various periods of immersion, and to determine at the same time the resistance to rupture of each of the combinations.

I shall afterward examine the natural substances analogous to these several artificial combinations: indicating how they may be known, and showing the abundance of these hydraulic substances in nature.

Following my observations on the resistance of artificial hydraulic pastes, I shall give analogous experiments applied to the comparison of a great number of natural hydraulic pastes, and mortars made of these pastes.

## ARTICLE XX.—*Artificial combinations of Lime and Clay.*

*Lime.* Without going into details as to the chemical properties of lime, it may suffice to say that this substance forms the base of limestones, and gypsum, or plaster of Paris; and that it combines, at a high temperature, with silex, forming what is called a silicate of lime. In the humid way, it appears to combine with clay, either crude or calcined, affording a hydrosilicate with a base of lime and alumine.

Lime, as it is used in making mortars, is obtained by the calcination of limestones, which are carbonates or subcarbonates more or less pure, found in all the formations; it is obtained also from some animal productions, as shells of oysters, and other shells.

The effect of calcination is to drive out the water and carbonic acid. By breaking the stone into pieces about one and a half inch square and passing a current of steam through the ignited mass, a cubic metre (35.32 cubic feet) of lime stone may be converted into lime, in a kiln with a continual fire, by burning about seven cubic feet of sea-coal:* in cold and moist seasons the consumption of coal is augmented; and amounts, sometimes, to a third of the volume of the stone.

If the limestone be argillaceous, the fire should be managed cautiously, and be less violent than to calcine a nearly pure carbonate of lime; for when the fire is too high, the lime and clay fuse, and give a vitreous matter inert, or without causticity, which is a double silicate of lime and alumine.

Whenever a piece of limestone is cooled before the calcination is completed, it becomes necessary to wet it before putting it again in the kiln; without this precaution, it would be very difficult to reduce it completely to lime.

After calcination, lime has a great affinity for water, and augments in volume, by absorbing it. If a certain quantity of water be thrown on lime recently calcined, it heats, splits open, and is reduced to powder, or paste, according to the quantity of water absorbed; during this operation, a little water is carried off by the heat; but, when the lime is obtained from a nearly pure limestone, the volume of paste after slaking, is, sensibly, equal to the volume of water absorbed.*

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* On the canal of Ardennes, where I caused large quantities of lime to be burned, the lime burners threw into the kiln one measure of sea-coal to five, six and even seven measures of limestone; it should be observed, however, that the stone was a chlorite-chalk, easier to convert into lime than limestones generally.

At Theil in the department of Ardèche, whence the best hydraulic lime that I know of is derived, they consume but one sixth of a measure of sea-coal in burning one measure of lime. AUTHOR.

*Clay.* Clays are composed of silex and alumine in variable proportions, often mixed with quartzose sand, oxide of iron, magnesia and lime. When the clays contain no sand, they are fine and soft to the touch; and form with water an unctuous paste susceptible of being moulded into any form.

The clays which I chiefly used are those of which the analyses are given in columns 1, 2, 3, and 4, of table LVII.

*Combinations of Lime and Clay.* If crude clay be mixed with various proportions of lime, pastes are formed which have much more consistence than clay alone: this paste, put under water, acquires at the end of three days, a certain hardness which it preserves, afterward, indefinitely; it attains its maximum of resistance, when one part of lime is mixed with nine parts of clay; this paste, after three days, resists the pressure of the thumb.

When a mixture of lime and clay, exposed for some days to the air, has lost a part of its water, without having been dried too rapidly, it may be afterward immersed without sustaining any alteration, provided the volume of lime be not greater than one third that of the clay; the proportion of lime might be less but should not be greater. A mortar of this sort might be used in the construction of cisterns, reservoirs, and other works, where an insoluble, rather than a strong, mortar is needed. I regret not being able to state the actual resistance of mortars made of lime and crude clay, but at the period I was occupied with these first researches, the hardening under water was the property to which I confined my attention.

The quality of augmenting the resistance of lime, which crude clay possesses appears to have been known for a long time in *Champagne*, where all the wooden houses are covered, exteriorly, with a plaster composed of lime and a white argillaceous and calcareous earth. The floors are also made with a plaster of the same nature, and when not dried too rapidly, they resist perfectly.

This property explains how it is that sand, mixed with a certain quantity of crude clay, forms a mortar with lime, which acquires a degree of hardness under water that does not, however, increase after some days.†

If fat lime, and clay containing little or no calcareous matter, be mixed, 1, 2, 3, 4, 5, 6, 7, 8 and 9, parts of clay, respectively, with 9, 8, 7, 6, 5, 4, 3, 2 and 1 parts of lime, a series of eleven compounds will be formed, of which the first term will be pure lime, and the last, pure clay; if the last ten compounds be calcined, substances will result possessing the properties about to be described.

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*In a considerable number of experiments that I had occasion to make in 1823, I always obtained the above relation between the bulk of the slaked lime, and the absorbed water; the quantities of lime on which I experimented, varied from three and a half to ten and a half cubic feet. Au.

†The sands now referred to must not be confounded with those which contain, in their interstices, mud or slime more or less charged with animal or vegetable matter; when this last kind of sand is used, the lime forms, with the animal or vegetable substance, a soap, more or less soluble, which opposes the hardening of the mortars. Sands of this kind, if not washed free from these matters before they are used, always give very bad results. Author.

*Hydraulic lime.* The first two mixtures will give hydraulic lime, as Mr. Vicat has long since made known.

The lime of the first compound is moderately hydraulic, hardens slowly in water, and takes, in time, the consistence of hard soap.

The lime of the second, acquires, after three days immersion, the hardness of chalk: after 20 days immersion, it permits a stem 0.08 inch in diameter, loaded with 2.20 lbs. falling from a height of two inches, to penetrate 0.12 inch: and after two months immersion, it shows no sensible impression from the shock of the stem.

On mixing the lime of the first two compounds with fat lime, they divide with this last their hydraulic properties; but these properties decrease quite rapidly. Hydraulic lime containing 0.20 of clay, mixed with an equal volume of fat lime, acquires at the end of two months the hardness of lime containing 0.10 of clay. By this kind of mixture, the energy of lime, slightly hydraulic, is sensibly augmented; a lime which would take only a feeble consistence when alone in water, acquired, by mixture with one quarter, or only one fifth, of very hydraulic lime, the properties of limes that are moderately hydraulic.

*Lime-cement.* The four following compounds, containing 3, 4, 5, and 6 parts of clay united with 7, 6, 5, and 4 parts of lime, give, by calcination, substances that slake slowly, disengaging but little heat; but when pulverized and made into paste, increase in volume, and acquire, promptly, great hardness under water. Their augmentation of volume continues some time after they have commenced hardening; for if a glass be filled therewith, it splits in all directions, but the cracks do not become apparent till a month or two after it has acquired a hardness equal to that of chalk. This augmentation of volume, which breaks the glass in which the experiment is made, is however but slight; for when the paste is made into the form of bricks, it is rare that it presents fissures. Each of these compounds mixed with an equal volume of sand, and even with a double volume, gives a hydraulic mortar which, after six hours immersion, resists the pressure of the thumb: and after eight days, perfectly resists the shock of the stem above spoken of.

Besides the properties mentioned, the same compounds communicate to fat lime their hydraulic qualities; imparting all the energy of lime eminently hydraulic.

If 1, 2, 3, 4, 5, 6, 7, 8 and 9 parts of the powder of each of these compounds be taken, and mixed respectively with 9, 8, 7, 6, 5, 4, 3, 2 and 1 parts of fat lime, different degrees of hydraulic property will be given to the latter: with five parts of powder, a lime eminently hydraulic will be obtained: two parts of powder will suffice to make eight parts of lime hydraulic; but, one part of powder will communicate only a feeble degree of hydraulic property to nine parts of lime; after eight days' immersion, this last mixture will hardly have the consistence of moist soap.

If, an hour after the mixture, all the pastes made of the lime and powder, above mentioned, be immersed, they will set under water in six days for the least hydraulic; after that time, the hardest will resist the pressure of the thumb. Each of these pastes mixed with a volume of sand equal to the volume of paste at least, and to twice the volume of paste at most, will give a mortar which will harden in water a little less rapidly than the paste without the sand.

The compound of five parts of lime and five parts of clay is that which gives the most energetic powder.

According to the proportions of lime and powder, the paste is more or less gritty or more or less unctuous, but all harden in a short time after immersion: for example the powder derived from the compound of four parts of lime and six parts of clay gave results sensibly the same as those derived from a compound of six parts of lime and four parts of clay.

The compounds of which we have been speaking enjoy, therefore, the properties of lime and cement, at the same time. When mixed, alone, with sand, they serve to make mortars--acting, in this respect, like lime; when, on the other hand, they give hydraulic properties to lime, they, in that respect, act like cement: this double property has induced me to designate them by the term *lime-cement.*

*Hydraulic Cement.*—The terms of the series composed of 7, 8, and 9 parts of clay, respectively mixed with 3, 2 and 1 parts of lime, give, by calcination, substances that do not slake: their colour is more or less reddish, according to the greater or less quantity of oxide of iron in the clay. These matters being pulverized and made into paste, form a mortar, more or less meagre, which hardens under water in the space of ten days.

The powders of these compounds, mixed with various proportions of fat lime, give hydraulic pastes which harden under water in a few days.

These compounds being true cements, enjoying the property of hardening when alone under water, it seems convenient to designate them as *hydraulic cements* in order to distinguish them from *common cement* which, when alone, will take no consistence under water.

*Common cement.*--Clay, as has been long known, gives, by calcination and pulverization, a cement that being mixed with fat lime in various proportions, forms a mortar that hardens slowly under water, but which in time acquires a degree of hardness superior to that of hydraulic lime, either alone or mixed with sand, as we shall have occasion to show when on the subject of resistance to rupture of hydraulic paste and mortar.

*Mode of mixing.*—All the mixtures or combinations spoken of were made at the moment of slaking the lime*, or a short time afterwards.

When lime has been slaked for several days, the pastes and mortars split under water, take but little consistence, and seem to abandon their lime; which does not occur, or is much less sensible, when lime newly slaked is used: I content myself with stating the fact, without pretending to explain it.

When the lime is immersed while hot, an analogous effect is observed ; but then it is caused by the swelling of a paste not saturated with water before the immersion.

The mixtures should, therefore, be made at the moment of slaking, but they should not be immersed for three or four hours afterward, if the volume is small, nor for twenty or thirty hours afterward when the bulk is considerable.

*Mode of experimenting.*—In the first experiments I had occasion to make, I mixed fat lime with a brick earth of which the analysis is given in the first column of table LVII.; this earth containing hardly $\frac{1}{50}$ of calcareous matter gave combinations possessing all the properties described above.

At this first period of the experiments--then less methodical than afterward, I contented myself with putting into the glasses, volumes of paste occupying about a third of their capacity, and then pouring on water to fill the vessel. I subsequently measured the degree of advancement of the induration, by letting fall, from a height of two inches, a stem of iron $\frac{8}{100}$ of an inch in diameter, and loaded to weigh 2.2 lbs.

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* The slaking was always done by the ordinary process, that is to say by adding to the lime in a basin, the necessary quantity of water.—*Author.*

In a second series of experiments, I made use of argillaceous earth of which the analysis is given in the second column of the table LVII: this earth, as the analysis shows, contains nine per cent. of lime: it therefore gave pastes less resisting, and of a less prompt induration, than the preceding.

The volumes of paste were equal. To this end they were moulded in a hollow tin prism 1.8 inch long and 1.2 inch square: the substance thus moulded was, while still soft, forced out of the tin prism by a piece of wood of the same form and size, and placed at the bottom of a glass; each prism thus deposited at the bottom of a glass, remained half an hour exposed to the air and was then covered with water.

In mixing successively 9, 8, 7, 6, 5, 4, 3, 2, and 1 parts of the powder of the *ten combinations of the first order* with 1, 2, 3, 4, 5, 6, 7, 8, and 9 parts of fat lime, I obtained 100 combinations of the second order, or, in other words, one hundred different hydraulic pastes.

The figures of the two horizontal lines at the top of tables LIX. and LX., indicate the respective numbers, first, of the parts of the substances *a*, contained in the second column as combinations of the first order; second, of the parts of fat lime, which were mixed therewith to form the combinations of the second order.

The pastes of the same vertical column are, consequently, composed of the same number of parts of fat lime mixed successively with a certain number of parts of the several matters *a*, or combinations of the first order, mentioned in the second column of the table.

*Hardening of Hydraulic Pastes.*—To measure the degree of advancement of the induration of the several hydraulic pastes, I could not use the stem loaded with 2.2 lbs. of lead, because it would certainly have broken the prisms: I replaced it by another $\frac{48}{1000}$ of an inch in diameter, loaded with lead so as to weigh $\frac{2}{3}$ of a pound.

Fifteen days after the immersion, each prism, withdrawn from the water in which it had been immersed, was submitted to the shock of the stem just described, falling from the height of $\frac{8}{10}$ of an inch only; the number inscribed in each column of the table LIX, indicates the penetration for each prism.

Several prisms perfectly resisted the shock, and sustained no sensible penetration: others presented irregularities in their resistance without any apparent cause.

Two months after the immersion, the prisms were submitted to a second proof; the stem falling, then, from a height of $1\frac{6}{10}$ inch; the numbers expressive of the degree of penetration of the stem into each prism, are given in table LX.; as the effect of the shock should be double in the second proof what it was in the first, and as the degree of penetration had generally diminished, it results that in the space of forty days the resistance of all the hydraulic pastes was more than doubled.

After four months immersion, the stem, let fall from a height of $2\frac{4}{10}$ inches—the greatest height the instrument would allow, produced no sensible effect on the greater part of the prisms.

*Resistance to rupture of hydraulic pastes.*—At this period I thought it proper to measure the resistance to rupture. To obtain this resistance, I operated with each hydraulic paste, on a prism 1.80 inch long, and 1.20 inch square, making use of an arrangement similar to that described by General Treussart in his work on mortars. Each prism passed through a small iron stirrup, and rested on two supports which were 1.20 inch apart; from the stirrup was suspended a scale-pan on which was placed, successively, greater and greater weights: that which caused the rupture was noted, and augmented by the weight of the stirrup and scale-pan, which was 12.10 lbs. The numbers indicating the weights that broke the prisms, are inserted in table LXI.

The results comprised in table LXI. present some anomalies, of which several were caused by voids that were found in a number of the prisms: others supported greater weights than was to be expected from their composition, without my being able to assign the cause.

The same table shows that lime moderately hydraulic, containing 0.10 of clay and 0.90 of lime, mixed in different proportions with fat lime, afforded prisms which supported from 29.0 lbs. to 66 lbs.

It also shows that very hydraulic lime, containing 0.20 of clay and 0.80 of lime, in the same circumstances, gave prisms that supported from 53 lbs. to 207 lbs.

That prisms of lime-cement mixed with different proportions of fat lime, supported from 53 lbs. to 440 lbs.

That prisms of hydraulic cement and fat lime, supported from 44 lbs. to 363 lbs.

That prisms of common cement and fat lime, sustained from 0.00 to 356 pounds.

A prism of common burnt brick, such as is used at *Rive-de-Gier,* having exactly the dimensions of the prisms of hydraulic paste, broke under a weight of 117 lbs.

Of the 100 prisms tried, 69 had strength superior to this well burned, but coarse grained, brick.

*Resistance of mortars to rupture.*—At the same time that the prisms of hydraulic paste were moulded, the same pastes were mixed with double the volume of sand, forming one hundred hydraulic compounds inserted in tables LIX, LX, and LXI. Combinations were thus formed of a third order, which we call mortars; these were moulded into prisms 4 inches in length by $1\frac{8}{10}$ inch square.

After four months immersion, the resistance to rupture of these mortar prisms was determined. To this end each prism was passed through a stirrup and made to rest on supports that were two inches apart: to the stirrup was appended a scale-pan in which weights were placed to cause the rupture: the weight which effected the rupture, increased by that of the scale-pan and stirrup, which was $12\frac{1}{10}$ lbs., was noted. The weights thus determined are inserted in table LXII.

These numbers are much weaker than might be expected from the resistances afforded by the hydraulic pastes (table LXI:) which deficiency in the resistances of these mortars, appears to be due to the quantity of sand, which was generally too great: in fact, *lime cements, and cements,* contain within themselves a certain quantity of matter not susceptible of slaking, and which, consequently, acts as sand: the portions of true hydraulic paste which should serve to bind together the sandy particles, were therefore in too small quantity in the greater number of the prisms.

I wished to leave the mortars immersed during at least one year, but time failed me.

A prism of common burnt brick, having exactly the dimensions of the prisms of mortar, broke under the weight of 240 lbs.

Of the 100 mortar prisms submitted to trial, there were but 5 that were superior to the brick prism.*

From what precedes, results the following classification of combinations, elementary in some sort, which may enter into the composition of mortar.†

1st. *Fat lime*—which does not contain clay, or in which the clay is less than the $\frac{1}{10}$.
2nd. *Hydraulic lime*—which contains that of $\frac{1}{5}$ of clay.
3rd. *Lime cement*—which contains from $\frac{1}{5}$ to $\frac{3}{5}$ of clay.
4th. *Hydraulic cement*—which contains from $\frac{2}{5}$ to $\frac{1}{10}$ of lime.
5th. *Common cement*—in which the lime is wanting, or exists in quantity less than $\frac{1}{10}$.

## ARTICLE XXI.—*Natural Combinations of Lime and Clay.*

*Limestones capable of affording hydraulic lime.*—Lime, silex and alumine, the elements necessary to hydraulic lime, are substances that Nature affords in abundance in the secondary and tertiary formations: the crust of the globe is almost entirely formed of them: each of these substances alone, forms layers more or less thick, which often alternate with the others: this alternation is to be seen whenever, in the same formation, there is a change in the nature of the rock: thus, as is frequently seen, strata of clay, alternate with calcareous layers, and with strata of sand stone or free stone. When this happens it is rare that the stratum is entirely composed of the one substance; in the passage of the calcareous strata, for example, there are formed, first, calcareous strata containing a small quantity of clay, then, becoming more argillaceous, passing often to the state of marle, and at last, the clay is found almost alone, or without mixture of lime. When a succession of this nature is presented, it may be conceived not to be difficult to find a calcareous layer wherein the clay will exist in proportions suitable for hydraulic lime.

The preceding observation has often been useful to me in directing my search for natural hydraulic limes. In the Jura limestone formation (*formation Jurassique.*) for example, where such alternations are frequent, I have found hydraulic lime: 1st. near *Brabant* (Meuse,) in the oolitic beds which alternate with beds of clay: 2nd. near *Villers-le-Tourneur* (Ardennes,) in other oolitic layers, presenting the same alternations: 3rd. near Joinville (Haute-Maine.)

For a long time, a bed of gryphite lias, alternating with beds of clay, and which gives a lime slightly hydraulic, has been quarried near Lyons.

Near Macon, there exists a quarry of the same kind in the oolitic layers; the lime of Sury (Loire,) and that of Theil (Ardèche,) which are very hydraulic, are derived from some layers of lias found under analogous circumstances.

In the inferior layers of the chalk formation, where the same alternations are remarked, I very easily found hydraulic limes at different points on the limits of the formation, as Saint-Menehould, Rethel, and Vitry-le-Français.

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* When on the subject of natural *lime-cements* and of *common cements*, I shall refer to mortars that supported, after four months, a load almost twice as great as the greatest inserted in the table.—*Author.*

† In almost all localities, Nature offers the materials proper to form the different elements of mortar, in abundance; as will be shown in the following article.—*Author.*

In the tertiary formation, having noticed alternations of lime and clay near Hermonville (Maine,) near Valsery (Aisne) in the calcareous beds containing cerithiœ, and lastly, near Chateau-Thierry, in the strata of siliceous limestones, it was easy to point out the layers which it was proper to try, in searching for hydraulic lime.

The preceding observation is always true for the beds of the same formation; but it ceases to be exact at the point of passage of different formations. The chalk formation, for example, is often covered with the plastic clay which belongs to the tertiary: but these two layers appertain to two distinct formations; the first had existed for a long time before it was covered by the second; the calcareous matters not having been produced simultaneously, the two substances are simply juxtaposited, without alternation or mixture.

We may conclude, from what precedes, that whenever limestone is found alternating with clays or marls, one or several of the layers will give hydraulic lime. Five or six trials with small specimens will suffice to show which of the layers should be quarried.

I will terminate what relates to natural hydraulic limes by stating the process to which I submitted some of the limes, and the mortars into the composition of which they entered.

The experiments on the natural hydraulic pastes, and on the mortars made from them, were conducted under the same circumstances as the experiments mentioned in tables LXI and LXII, with the artificial combinations.

The prisms of hydraulic paste were $1\frac{8}{10}$ inch long and $1\frac{2}{10}$ inch square, and were placed on two supports which were $1\frac{2}{10}$ inch apart.

The prisms of mortar were four inches long and $1\frac{8}{10}$ inch square, and were placed on supports which were two inches apart.*

The same stirrup rested on the prism, and had suspended from it the scale pan, weighing, together with the stirrup, $12\frac{1}{10}$ lbs.

The lime derived from Theil (Ardèche) is the most powerfully hydraulic of any I have met with: it is obtained by burning a limestone of which the analysis will be found in the fourth column of table LVII.

A prism of this lime having exactly the same dimensions as those of the hydraulic pastes in table LXI, broke under a weight of 229lbs; its resistance, after four months immersion, was, consequently, double that of a brick of the same dimensions.

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*Knowing the resistance E of a prism of matter having the dimensions of those of the hydraulic paste, it is easy to determine the resistance E′ of a prism of the same substance having the dimensions of the prisms of mortar; by using the formula $E=R\frac{ab^2}{c}$ in which $a$ is the breadth of the prism, $b$ its depth, and $c$ the distance between the supports.

For other dimensions we have $$E'=E\frac{\frac{a'(b'^2)}{c'}}{\frac{a(b^2)}{c}}$$

And in substituting for $a$, $b$, $c$ and $a'$, $b'$, $c'$ the above values, we find

$$E'=2.025\ E.$$

Author.

In table LXIV, I have given the results of the proofs to which I submitted different prisms of mortars composed of Theil lime mixed with different quantities of sand: these mortars after one month broke under a weight varying from 59lbs. to 81lbs. Mortar composed of one part of lime and four parts of sand, broke under a weight of 59lbs., and that composed of one part of lime and one and a half part of sand, broke under a weight of 81lbs.

A prism of mortar composed of one part of Theil lime and two parts of sand, after four months immersion, broke under the weight of 469lbs.; the resistance of the mortar was, consequently, six times that of the same mortar one month old, and twice that of a brick.

In the environs of *Rine de Geir*, are the remains of a Roman aqueduct which conveyed a part of the waters of the Saint Etienne to Lyons; I extracted from these ruins a piece of mortar which appeared to be as hard as stone, and cut it carefully to the same dimensions as the prisms that had been tried: the prism of this mortar sustained a weight of 519lbs., only 50lbs. more than was borne by the prism made of Theil lime.

A prism of mortar composed of one part of lime from Vitry le Français, and two parts of sand, sustained, after four months immersion, a weight of 145lbs.

The lime from Sury (Loire,) which is generally regarded as very hydraulic, mixed with double its volume of sand, gave a prism of mortar which, after four months' immersion, broke under the weight of 64lbs. The resistance of this mortar was therefore hardly equal to the seventh of that of the mortar made of Theil lime. The small resistance of the mortar made of Sury lime, the hydraulic quality of which has been long known, resulted doubtless from some defect in the prism—perhaps an imperceptible crack.

### *Calcareous Stones and Earths which afford Lime-cements.*

Every locality does not present the alternation of limestone and clay which facilitates the research for natural hydraulic limes; and it often happens that there is but one rock, and that, nearly homogeneous. Towards the middle of the chalk formation between Chalons and Troyes, the chalk is an almost pure calcareous carbonate, in which we seek in vain for a layer sufficiently argillaceous to afford hydraulic lime. The calcareous rocks, so abundant in the tertiary and secondary, are almost entirely wanting, or are only rarely found, in the lower formations. In these formations, there is no room for choice; it is necessary to use such limestone as can be found, and these rarely contain the proportion of clay that will yield hydraulic lime; but it is not rare to find, in these localities, substances which will give, by a moderate calcination, the *lime cements.* The greater part of the marls are of this sort, the clay and the lime composing them existing in variable proportions comprised within the limits affording *lime cements*: these substances are very common in France, and it will be as economical as advantageous, to give to fat lime the required degree of hydraulic property by mixing therewith marls calcined and pulverized.

When we are at liberty to choose, the marls that contain little or no sand should be preferred, so that the hydraulic paste which they assist in forming may bear the greater proportion of sand, and give a greater volume of mortar.

The calcination of marls requires a degree of heat less than that necessary to the calcination of limestone: when the fire is too great they vitrify, and form a double silicate with base of lime and alumine; when the fire is less ardent, they give a compact substance of which the fracture is slightly vitreous; this matter is difficult to pulverize, and gives a nearly inert cement; when the degree of heat is just sufficient, the fracture is dull, and the substance is generally easy to pulverise. Such wheels as are used in extensive works, for making mortar, will suffice to this end. When the degree of heat is insufficient, the cement is mixed with earthy portions which impair its energy.

It is difficult to give a general rule for the calcination of marls, because some require a degree of heat quite elevated. To ascertain, by an easy experiment, the degree of heat that each kind requires, the portion may be moulded into the form of a cylinder $4\frac{8}{10}$ inch in length by $1\frac{2}{10}$ inch in diameter, and exposed, one end in a violent fire, and the other on, or near, the outside of the fire; when the most highly heated end has begun to vitrify, the cylinder may be withdrawn from the fire and divided into four parts according to the apparent effects of the different degrees of calcination: by pulverizing each, it is easy to determine the degree of calcination which gives the most energetic cements: to prevent the cylinder breaking in the fire it is necessary to mould it around a wire.

It is requisite that the burned marl be pulverized, before the mixture with the lime; otherwise, the marl will absorb water, which will impair the energy of the powder, and prevent its intimate combination with the lime.

I had occasion to try several marls from the Departments of Loire, Ardennes, Maine and Rhone; they all gave good results. Parker's cement (English,) the Boulogne pebbles, and the Saint-Leger cement, are derived from marly stones which contain about as much clay as lime.

The Senonches lime comes from a marl containing more lime than clay: all these substances are, consequently, so many lime cements.

I made numerous experiments with three kinds of marl the analyses of which are inserted in table LXVII, columns Nos. 6, 7 and 8.

The first comes from Saint-Just. department of Loire, the second from Aubigny in the same department, and the third from the Rhone at Lyons and at Givors.

The marl of Saint-Just contains only 36 parts of lime united with 41 parts of clay; this marl, calcined and pulverized, gives a very energetic lime cement.

The 5th and 6th experiments of table LXIII, prove that 8 and 7 parts of powdered marl united with 2 and 3 parts of lime, gave a hydraulic paste which, hardly two months old, sustained the weight of 361 and 312lbs.

The experiments 27, 28, and 29 of table LXIV, show that mortars four months old, composed of a hydraulic paste, half of which was made up of powdered marl from Saint-Just, mixed with twice its volume of sand, broke under the weight of 92lbs. The want of resistance in these mortars arises from the excess of sand. The Aubigny marl contains only twenty-five parts of lime to fifty-five parts of clay: this marl, calcined and pulverized, affords a lime-cement of moderate energy.

Experiments Nos. 11, 12, 13 and 14 of table LXIII show:

1st. That a prism of the powder, after four months immersion, broke under the weight of 154lbs.

2nd. That a prism of 9 parts of this powder, mixed with one part of fat lime broke under the weight of 141lbs.

3rd. That prisms of 8 and 7 parts of the powder, mixed with 2 and 3 parts of fat lime supported only 66 and 44lbs respectively.

The resistances of the prisms of mortar composed of powdered Aubigny marl, fat lime and sand, present much fewer irregularities than the prisms of paste.

Experiment No. 31 of table LXIV, shows that a prism of mortar made of one part of the powder and two parts of sand, immersed for four months, broke under a weight of 35lbs.; while experiment No. 34 proves that a prism of mortar composed of 4 parts of fat lime united to 6 parts of the powdered marl and 20 parts of sand, did not break till the load amounted to 174lbs.

The slight resistance of prism No. 31 results, evidently, from the excess of sand mixed with a powder whereof more than half already performed the office of sand, so that the prism contained hardly $\frac{1}{5}$ of powder susceptible of conversion into lime.

The Givors marl contains only 24 parts of lime united with 55 parts of clay, but, after burning, it is easier to pulverise than the marl of Aubigny, and gives a more energetic powder.

Experiment No. 3 of table LXIII, shows that a prism of this powder made into paste, after two months immersion, supported 222lbs.

Experiment No. 4 shows that another prism, of which the paste was composed of 4 parts of fat lime united to 6 parts of the powder, broke with the weight of 165lbs.

Experiment No. 26 of table LXIV, shows that a prism of mortar, one month old, composed of 1 part of powdered marl and three parts of sand, broke with the load of 37lbs.

Experiment No. 13 shows that a mortar composed of 1 part of the marl in powder and 2 parts of sand, broke under the weight of 51lbs., while experiment No. 23 shows that a mortar composed of two parts of powdered marl and 1 part of sand, sustained the load of 224lbs. Sand mixed with pastes made of powdered marl reduces their resistance, therefore, very much: this effect is less sensible with hydraulic pastes composed of fat lime and powdered marl, as seems to be proved by experiments No. 14, 15, 16, 17, 18, 19, 20, 21 and 22.

According to experiment No 22 of table LXIV, a mortar composed of 1 part of fat lime, 1 part of powdered marl and 2.40 of sand, broke with the load of 134lbs.

According to experiment No. 20, a mortar composed of 1 part of fat lime, 1 part of powdered marl, and 2.50 of sand, broke with the load of 136lbs.

And according to experiment No. 18, a mortar composed of 1 part of lime, 1 part of powdered marl, and 1.60 of sand, broke with the load of 139lbs.

These mortars being hardly a month old, the trials do not show sufficiently the influence of lime: I wished that more time should elapse, but being called away by particular circumstances, I preferred shortening the period to leaving out these trials.

### *Earths which will afford Hydraulic Cements.*

The substances that I have designated *hydraulic cements*, and which are composed of 7, 8, and 9 parts of clay, respectively mixed with 3, 2 and 1 parts of lime, are true artificial puzzolanas; for analysis has shown that natural puzzolanas contain about $\frac{1}{11}$ of lime combined with silex and alumine. The greater part of argillaceous earths, and marls, effervescing with acids, and containing less than 40 per cent. of lime, may, when they do not contain too much sand, give by calcination and pulverization, natural hydraulic cements, susceptible of hardening under water. Each of these cements without any addition of lime, may, on being mixed with a quantity of sand equal to its volume, constitute a hydraulic mortar, but this mortar is much too meagre to be employed in masonry.

The yellow and white marls, which are very common in Champagne, give good hydraulic cements: I have found some of this kind on the little hills west of the town of Rethel; I have also encountered it at other points in the valleys of the Aisne and of the Maine. These earths mixed with a certain quantity of sand, serve to make bricks which are very light after being burned. When these bricks have not been exposed to a fire of such intensity as to cause a beginning of vitrification, they acquire great hardness under water: several millions of these bricks were made under my inspection, and used in the works of the canal of Ardennes. When the substance of the brick is vitrified, mortar adheres to it but feebly. To form good masses of masonry, bricks of which the substance is not vitrified and which have preserved the red colour, should be preferred; these are, in fact, unpulverized cement, having much affinity for lime, and to which mortars adhere strongly.

*Clay, or argillaceous earth—Common Cement.*—All clays, or argillaceous earth, not calcareous, burned more or less and pulverized, afford *common cement.* The cement commonly used is made from fragments of bricks or tiles. When the argillaceous earths of which cements are to be made, are exposed to a high degree of heat, they begin to melt and become fritty; in this state the pulverization becomes difficult, and the cement they afford is inert, and but little different from sand.

Of all the common cements that I had occasion to try, the most energetic was derived from the clay of Bédouan, in the department of Ardèche; the results of the analysis of this clay, are to be found in the third column of table LVII.

Experiment No. 15 of table No. LXIII shows that a prism of hydraulic paste, composed of 2 parts of lime and 5 parts of cement, after four months immersion, broke under a weight of 759 lbs.: an equal prism of Theil hydraulic lime, the best that I know, supported only 229 lbs.

Experiment No. 50 of table No. LXIV shows that a mortar composed of 1 part of the above hydraulic paste and 1 part of sand, after four months immersion, broke under a weight of 733 lbs.

Mortar composed of 1 part of Theil lime and 2 parts of sand, broke with a load of 469 lbs.; an equal prism of mortar obtained from a Roman aqueduct, about sixteen centuries old, broke under a load of 519 lbs.

These experiments prove that the hydraulic pastes and mortars which acquire in a short time the greatest strength, are those which are composed of a cement analogous to that furnished by the Bédouan clay.

I concluded the experiments on common cements by seeking to ascertain whether iron would augment the energy of the clay: to this end I mixed with clay different proportions of a ferruginous mineral (carbonate of iron mixed with carbonate of lime) and I pulverized the whole after burning.

The experiments from No. 17 to No. 25 in table LXIII, show the resistances of the hydraulic pastes made of clay-cements and the mineral: experiments from No. 41 to 49 of table No. LXIV, show the resistances of the mortars composed of this paste. It results from these two series of experiments that the mineral does not augment the energy of the cement, and that it even diminishes it, when the clay contains more than two-thirds of the substance.

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### ARTICLE XXII.—*Summary and Conclusion.*

From all that precedes, it results, that in going over the combinations that may be obtained by mixing clay not calcareous, and fat lime, in various proportions, we get, first, *hydraulic lime*, which contains as high as $\frac{1}{5}$ of clay; the combinations above this, containing from $\frac{1}{5}$ to $\frac{3}{5}$ of clay, possess at the same time the property of lime and of cement, and for this reason I have designated them as *lime cements;* lastly, the higher combinations, containing from $\frac{3}{5}$ to $\frac{9}{10}$ of clay, may have applied especially to them, the name of *hydraulic cement*, because of their being susceptible of forming hydraulic mortars, alone, or with the addition of a small quantity of lime.

*Hydraulic lime.*—The properties of hydraulic lime being well known, I have no further occupied myself therewith than was necessary to complete the general examination of the combinations of lime and clay, and to present some observations on the superposition of those calcareous rocks that contain the quantity of clay necessary to produce natural hydraulic limes.

*Lime cements.*—The combinations that I have called *lime-cements* having been but little examined hitherto, I have given to the study of their different properties, particular care. These combinations burned, pulverized, made into paste and immersed, harden under water very promptly; mixed with an equal volume of sand, or even with a double volume, they give a very good hydraulic mortar; mixed with fat lime at the moment of slaking, they give to this lime a hydraulic power depending on the proportions of the mixture: 2 parts of *lime cement* make 3 parts of fat lime very hydraulic; a still smaller quantity of *lime-cement* might suffice, and but rarely would more be necessary; unless it were thought proper to give to the paste a hydraulic energy superior to that of the best limes.

Very argillaceous limestones, and the greater part of the marls, which are very common in France, give, by moderate burning, natural *lime-cements*; we may therefore give to fat lime, a suitable degree of hydraulic energy, by mixing with it certain quantities of burnt and pulverized marl; the proportions should vary with the energy of the particular kind of pulverized marl at command; but it will be rarely necessary to exceed the proportion of two parts of powdered marl to three parts of fat lime.

At Lyons, and on the canal of Givors, use is made, for works under water, of the eminently hydraulic lime of Theil; but the marls found near these localities, of which I have ascertained the properties, might, on being mixed with fat lime, be substituted advantageously for Theil lime, of which the cubic metre (35.34 cubic feet) costs $8.55. Half of fat lime at $3.04, and half of powdered marl at $1.90, will give a very hydraulic paste, of which the cubic metre will cost only $2.47: the economy that will result from the use of this paste will be very sensible in the prolongation of the canal of Givors, of which the works will consume 10,000 cubic metres of the Theil lime.

In those localities where fuel is dear, and where there is not a supply of either natural hydraulic lime, or of marl susceptible of affording a *lime-cement*, it will be better to use an artificial *lime-cement*, than an artificial hydraulic lime; in fact, in a quantity of hydraulic lime obtained by mixture of fat lime and *lime-cement*, the last substance forming, at most, the half of the total volume, its use will reduce, in this ratio, the cost of burning, and of fabrication; on the other hand, fat lime and *lime-cements* will be more easy to preserve than hydraulic lime; and there will be, moreover, the advantage of varying the degree of hydraulic energy, and of retarding the conversion of fat lime into hydraulic lime until the moment it is to be applied.

*Hydraulic cement.*—The combinations to which I propose affixing the name of *hydraulic cement*, possess the property of giving, either alone, or mixed with an equal volume of sand, an hydraulic mortar more or less meagre. These cements united with fat lime, form pastes which harden under water, within the space of fifteen days. 1 part of cement suffices to render 2 parts of fat lime hydraulic.

The greater part of argillaceous and calcareous earths—very common every where—are proper to afford hydraulic cements, by burning and pulverization: the burning should be moderated, to prevent the matter from becoming fritty and inert.

When these argillaceous or calcareous earths contain a certain quantity of sand, they serve to make bricks, which are true hydraulic cements not pulverized; these bricks are very light after burning, and appear to want strength unless they have sustained a commencement of vitrification; but they adhere strongly to mortars, and when they are used under water, they soon acquire all requisite hardness; if, during the burning, these bricks are highly heated, they become fritty, often without changing form; but, in this state, they adhere but slightly to mortars, the cement of which they are composed having then become completely inert.

At the canal of Ardennes I had occasion to apply a portion of the preceding observations; because for the works of that part of the canal which lies in the valley of the Aisne there were no other materials than the argillo-calcareous earth covering the bottom of the valley, and the tender, chalky rocks that formed the slopes, together with earth and stones as tender as the chalk.

Different trials made on a small scale showed me, however, that, with care, bricks might be made of the earth from the valley: other trials brought to light, in the gray or chlorite chalk, strata affording hydraulic lime, so that in the course of the years 1826, 1827 and 1828, locks and other works were built with bricks made of the earth of the valley, hydraulic lime from the chalk, and masses of chalk, laid behind the facings of bricks.

Even in a chalky region, where no other materials of construction can be found than chalk, marls, and argillo-calcareous earths, and where, for this reason, the greater number of buildings are of wood, we may, therefore, erect works as solid as elsewhere.

*Common cements.*—As to *common cements*, I will limit myself to saying that they are the more energetic as they are derived from clays the more refractory: I will say further, that it appears evident to me, the resulting hydraulic pastes and mortars afford more resistance than the analogous mortars composed of hydraulic lime.

Lastly, I will deduce from the second portion of the facts reported by me, that in every locality where limestones, marls, or argillo-calcareous earths are to be found, hydraulic pastes and hydraulic mortars may be obtained at small expense; and that the resistances of one and the other may be caused to vary from 44 lbs. to 759 lbs. for prisms 2 inches long by 1 $\frac{8}{10}$ inch square.

Such are the observations I have had occasion to make: I know they are very incomplete, and that enough has not been done to show the influence of time on the resistance of pastes and hydraulic mortars: but if the results at which I have arrived are deemed worthy of the attention of constructors, I shall have attained the object, I proposed to myself.

## Table No. LVII.

Analyses of several natural combinations of lime and clay, susceptible of giving after burning, hydraulic pastes, either alone or mixed with fat lime.

| | | Brick earth from Rive-de-gier. | White clay from Rive-de-Gier. | Clay from Bédoreau | Limestone from Theil. | MARLS | | | | Remarks. |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | From Echaur. | From St. Just. | From Aubigny, | From Givors. | |
| | | I | 2 | 3 | 4 | 5 | 6 | 7 | 8 | These analyses were made at the School of Mines of St. Etienne, by M. Socart, Chemist. I am indebted for them to Messrs Delsériès and Clapeyron, Engineers of Mines. |
| Water . . | | 8.00 | 5.80 | 12.00 | 3.00 | 6.20 | 6.80 | 12.20 | 13.20 | |
| Carbonate of lime | | | 9.20 | | 76.80 | 53.20 | 35.40 | 24.80 | 23.80 | |
| Carbonate of magnesia | | | 1.60 | | trace | 2.00 | 1.20 | 0.00 | 0.80 | |
| | | | | | 79.80 | 61.40 | 43.40 | 37.00 | 37.80 | |
| CLAY | Silex . | 57.80 | 60.00 | 52.00 | 14.40 | 22.00 | 26.00 | 38.40 | 39.60 | |
| | Alumine . | 19.60 | 14.80 | 28.00 | 2.80 | 7.20 | 15.00 | 11.60 | 7.00 | |
| | Lime . | 2.00 | | 3.00 | 1.20 | 1.40 | 2.00 | 5.40 | 8.40 | |
| | Magnesia | 0.00 | | 1.00 | 0.40 | 0.00 | 1.20 | 0.00 | 1.60 | |
| | Oxide of iron | 12.40 | 8.40 | 2.00 | 0.80 | 7.60 | 11.60 | 7.20 | 4.80 | |
| Totals . . | | 99.80 | 99.80 | 98.00 | 99.40 | 99.20 | 99.20 | 99.60 | 89.60 | |

## Table LVIII.

Analyses of natural combinations of lime and clay—extracted from the work of Gen. Treussart.

| | Clays. | | | Hydraulic Lime. | | | Lime Cements. | | | Hydraulic Cements. | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Pipe clay from Cologne. | From Frankfort. | From Sufflenheim. | From Saint Germain. | From Metz. | From Senonches. | Parker's cement, (English.) | Boulogne pebbles. | Cement from Pouilly. | Puzzolana. | Trass. | Calcined Basalt from Haute Loire. |
| | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 |
| Water | 6.60 | 16.00 | 7.80 | | | | | | | 9.20 | 9.60 | 2.00 |
| Lime | | | | 83.00 | 68.30 | 70.00 | 55.40 | 54.00 | 42.86 | 8.80 | 2.60 | 9.50 |
| Clay: Silex | 67.00 | 50.00 | 72.40 | | | | | | | 44.50 | 57.00 | 44.50 |
| Clay: Alumine | 24.00 | 32.70 | 11.80 | | | | | | | 15.00 | 12.00 | 16.75 |
| Clay | | | | clay 17.00 | clay 31.70 | clay 30 | clay 44.60 | clay 46.00 | clay 57.14 | | | |
| Clay: Magnesia | 1.20 | 1.50 | 2.00 | | | | | | | 4.70 | 1.00 | |
| Clay: Peroxide of Iron | 1.20 | | 4.80 | | | | | | | 12.00 | 5.00 | 20.00 |
| Potassa | | | | | | | | | | 1.40 | 7.00 | |
| Soda | | | | | | | | | | 4.00 | 1.00 | 2.60 |
| Oxide of Manganese | | | | | | | | | | | | 2.37 |
| Totals | 100.00 | 100.20 | 98.80 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 100.00 | 99.60 | 99.20 | 97.72 |

Table LIX.

Degree of penetration of a stem 0.047 inch in diameter, and $\frac{2}{3}$ of a pound av. in weight, falling from a height of 0.787 inch upon prisms of artificial hydraulic paste, immersed for 15 days.

| General Classification. | Substances (a) or combinations of the first order. | Combinations of the second order, or artificial hydraulic pastes, formed of a mixture of each substance (a) or combination of the first order, in various proportions with fat lime—the proportion being as follows, viz: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Substance (a) 10<br>Fat lime 0 | 9<br>1 | 8<br>2 | 7<br>3 | 6<br>4 | 5<br>5 | 4<br>6 | 3<br>7 | 2<br>8 | 1<br>9 |
| | | inch | inch | inch | inch | inch | inch | inch | inch | inch | inch |
| Common cement | 10 of burnt clay<br>0 of lime | 1.772 | 0.000 | 0.000 | 0.000 | 0.000 | 0.039 | 0.118 | 0.118 | 0.118 | 0.275 |
| Hydraulic cement | 9 of burnt clay<br>1 of lime | 0.039 | 0.000 | 0.000 | 0.000 | 0.078 | 0.078 | 0.118 | 0.078 | 0.590 | 0.512 |
| | 8 of burnt clay<br>2 of lime | 0.039 | 0.039 | 0.000 | 0.000 | 0.078 | 0.039 | 0.078 | 0.472 | 0.156 | 0.195 |
| | 7 of burnt clay<br>3 of lime | 0.039 | 0.039 | 0.039 | 0.078 | 0.156 | 0.039 | 0.078 | 0.156 | 0.236 | 0.275 |
| Lime cement | 6 of burnt clay<br>4 of lime | 0.078 | 0.118 | 0.078 | 0.039 | 0.039 | 0.078 | 0.236 | 0.118 | 0.551 | 0.236 |
| | 5 of burnt clay<br>5 of lime | 0.000 | 0.000 | 0.000 | 0.078 | 0.078 | 0.039 | 0.118 | 0.118 | 0.118 | 0.118 |
| | 4 of burnt clay<br>6 of lime | 0.000 | 0.039 | 0.039 | 0.118 | 0.118 | 0.039 | 0.195 | 0.195 | 0.195 | 0.275 |
| | 3 of burnt clay<br>7 of lime | 0.000 | 0.078 | 0.078 | 0.118 | 0.078 | 0.118 | 0.236 | 0.118 | 0.118 | 0.118 |
| Hydraulic lime | 2 of burnt clay<br>8 of lime | 0.118 | 0.078 | 0.156 | 0.156 | 0.156 | 0.236 | 0.473 | 0.195 | 0.275 | 0.195 |
| | 1 of burnt clay<br>9 of lime | 0.394 | 0.472 | 0.195 | 0.195 | 0.195 | 0.787 | 0.195 | 0.669 | 0.787 | 1.575 |
| Fat lime | 0 of burnt clay<br>10 of lime | 1.772 | | | | | | | | | |

## Table LX.

Degree of penetration of a stem 0.047 inch in diameter, and $\frac{2}{3}$ of a pound avoirdupois in weight, falling from a height of 1.575 inch upon prisms of artificial hydraulic paste, immersed for two months.

| General Classification. | Substances (a) or combinations of the first order. | Combinations of the second order, or artificial hydraulic pastes, formed of a mixture of each substance (a) or combination of the first order, in various proportions with fat lime—the proportions being as follows, viz: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Substance (a) 10<br>Fat lime 0 | 9<br>1 | 8<br>2 | 7<br>3 | 6<br>4 | 5<br>5 | 4<br>6 | 3<br>7 | 2<br>8 | 1<br>9 |
| | | inch | inch | inch | inch | inch | inch | inch | inch | inch | inch |
| Common cement | 10 of burnt clay<br>0 of lime | 1.772 | 0.000 | 0.000 | 0.009 | 0.039 | 0.078 | 0.118 | 0.118 | 0.156 | 0.275 |
| Hydraulic cement | 9 of clay<br>1 of lime | 0.078 | 0.159 | 0.000 | 0.000 | 0.039 | 0.039 | 0.039 | 0.039 | 0.078 | 0.118 |
| | 8 of clay<br>2 of lime | 0.078 | 0.019 | 0.000 | 0.000 | 0.000 | 0.019 | 0.019 | 0.039 | 0.078 | 0.118 |
| | 7 of clay<br>3 of lime | 0.039 | 0.039 | 0.000 | 0.019 | 0.019 | 0.019 | 0.039 | 0.078 | 0.118 | 0.275 |
| Lime cement | 6 of clay<br>4 of lime | 0.039 | 0.039 | 0.039 | 0.019 | 0.039 | 0.059 | 0.078 | 0.078 | 0.118 | 0.118 |
| | 5 of clay<br>5 of lime | 0.000 | 0.000 | 0.000 | 0.019 | 0.019 | 0.039 | 0.039 | 0.039 | 0.078 | 0.078 |
| | 4 of clay<br>6 of lime | 0.000 | 0.039 | 0.019 | 0.078 | 0.078 | 0.118 | 0.078 | 0.078 | 0.078 | 0.118 |
| | 3 of clay<br>7 of lime | 0.000 | 0.019 | 0.195 | 0.039 | 0.039 | 0.059 | 0.078 | 0.098 | 0.118 | 0.118 |
| Hydraulic lime | 2 of clay<br>8 of lime | 0.039 | 0.078 | 0.118 | 0.118 | 0.118 | 0.118 | 0.156 | 0.156 | 0.118 | 0.118 |
| | 1 of clay<br>9 of lime | 0.118 | 0.156 | 0.118 | 0.118 | 0.236 | 0.393 | 0.275 | 0.315 | 0.315 | 0.315 |
| Fat lime | 0 of clay<br>10 of lime | 1.772 | | | | | | | | | |

Table LXI.

Weights that broke the prisms of artificial hydraulic paste—immersed for four months.

| General classification. | Substance (a) or combinations of the first order. | Combination of the second order, or artificial hydraulic pastes formed of a mixture of each substance (a) or combination of the first order in various proportions with fat lime—the proportions being as follows, viz: | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Substances (a) 10<br>Fat lime 0 | 9<br>1 | 8<br>2 | 7<br>3 | 6<br>4 | 5<br>5 | 4<br>6 | 3<br>7 | 2<br>8 | 1<br>9 |
| | | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| Common cement | 10 of burnt clay<br>0 of lime | 0 | 209 | 334 | 356 | 290 | 229 | 143 | 139 | 59 | 33 |
| Hydraulic cements | 9 of clay<br>1 of lime | 59 | 262 | 297 | 255 | 297 | 218 | 180 | 194 | 121 | 19 |
| | 8 of clay<br>2 of lime | 33 | 321 | 249 | 363 | 319 | 275 | 235 | 125 | 154 | 44 |
| | 7 of clay<br>3 of lime | 194 | 356 | 350 | 257 | 205 | 300 | 119 | 143 | 73 | 55 |
| Lime cements | 6 of clay<br>4 of lime | 152 | 249 | 229 | 255 | 255 | 185 | 141 | 130 | 68 | 53 |
| | 5 of clay<br>5 of lime | 438 | 235 | 387 | 185 | 180 | 341 | 194 | 132 | 99 | 48 |
| | 4 of clay<br>6 of lime | 396 | 183 | 275 | 172 | 200 | 119 | 121 | 108 | 99 | 64 |
| | 3 of clay<br>7 of lime | 194 | 178 | 304 | 156 | 147 | 136 | 77 | 161 | 123 | 79 |
| Hydraulic cements | 2 of clay<br>8 of lime | 139 | 207 | 114 | 134 | 152 | 0 | 81 | 106 | 84 | 53 |
| | 1 of clay<br>9 of lime | 70 | 75 | 86 | 97 | 51 | 44 | 40 | 33 | 33 | 29 |

## Table LXII.

Weights which broke prisms of *mortar* or combinations of the third order—immersed during four months, and composed of the several artificial hydraulic pastes mentioned in the preceding table—mixed with double the volume of sand.

| General classification. | Substances (a) or combinations of the first order. | Combinations of the third order, or mortars made by mixing each of the hydraulic pastes of the second order mentioned below—with double its volume of sand NB. The several hydraulic pastes are composed as in the preceding tables, viz. | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Substance (a) 10<br>Fat lime 0 | 9<br>1 | 8<br>2 | 7<br>3 | 6<br>4 | 5<br>5 | 4<br>6 | 3<br>7 | 2<br>8 | 1<br>9 |
| | | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. | lbs. |
| Common cement | 10 of burnt clay<br>0 of lime | 0 | 161 | 99 | 183 | 169 | 185 | 132 | 123 | 79 | 75 |
| Hydraulic cement | 9 of clay<br>1 of lime | 48 | 147 | 163 | 143 | 183 | 185 | 205 | 114 | 117 | 55 |
| | 8 of clay<br>2 of lime | 73 | 128 | 167 | 174 | 161 | 326 | 198 | 134 | 183 | 141 |
| | 7 of clay<br>3 of lime | 95 | 187 | 147 | 128 | 200 | 123 | 167 | 106 | 119 | 44 |
| Lime cement | 6 of clay<br>4 of lime | 75 | 222 | 209 | 198 | 169 | 224 | 158 | 114 | 141 | 55 |
| | 5 of clay<br>5 of lime | 185 | 75 | 200 | 209 | 218 | 178 | 154 | 139 | 119 | 70 |
| | 4 of clay<br>6 of lime | 51 | 350 | 290 | 407 | 277 | 165 | 156 | 187 | 141 | 176 |
| | 3 of clay<br>7 of lime | 152 | 156 | 218 | 275 | 202 | 249 | 101 | 202 | 172 | 211 |
| Hydraulic lime | 2 of clay<br>8 of lime | 150 | 187 | 145 | 172 | 145 | 191 | 200 | 150 | 134 | 121 |
| | 1 of clay<br>9 of lime | 143 | 128 | 152 | 167 | 134 | 112 | 106 | 55 | 70 | 73 |

## Table LXIII.

Resistance to rupture of prisms of paste of various natural hydraulic substances.

| Nos. in the series. | Nature of the hydraulic paste. | Age of the paste or duration of immersion. | Fat lime and Hydraulic lime. | Hydraulic cement and lime cement. | Weight which caused rupture. |
|---|---|---|---|---|---|
| | | | | | lbs. |
| 1 | Theil lime | 4 mo. | 1 | 0 | 228 |
| 2 | Pouilly cement | do. | 0 | 1 | 431 |
| 3 | Givors' marl alone | 2 mo. | 0 | 1 | 222 |
| 4 | do. and fat lime | do. | 4 | 6 | 165 |
| 5 | St. Just marl, and fat lime | do. | 2 | 8 | 361 |
| 6 | do. | do. | 3 | 7 | 312 |
| 7 | do. | do. | 6 | 4 | 167 |
| 8 | do. | do. | 7 | 3 | 132 |
| 9 | do. | do. | 8 | 2 | 88 |
| 10 | do. | do. | 9 | 1 | 77 |
| 11 | Aubigny marl, alone | 4 mo. | 0 | 1 | 154 |
| 12 | do. and fat lime | do. | 1 | 9 | 141 |
| 13 | do. | do. | 2 | 8 | 66 |
| 14 | do. | do. | 3 | 7 | 44 |
| 15 | Cement from Bédouan clay and fat lime | do. | 2 | 5 | 759 |
| 16 | Prism of burnt earth | do. | | | 194 |
| | Clay cements and a ferruginous cement burnt together and pulverized. | | | | |
| 17 | 9 of clay and 1 of the minerals | 3 mo. | 2 | 5 | 209 |
| 18 | 8 do. 2 do. | do. | 2 | 5 | 218 |
| 19 | 7 do. 3 do. | do. | 2 | 5 | 308 |
| 20 | 6 do. 4 do. | do. | 2 | 5 | 114 |
| 21 | 5 do. 5 do. | do. | 2 | 5 | 216 |
| 22 | 4 do. 6 do. | do. | 2 | 5 | 273 |
| 23 | 3 do. 7 do. | do. | 2 | 5 | 224 |
| 24 | 2 do. 8 do. | do. | 2 | 5 | 136 |
| 25 | 1 do. 1 do. | do. | 2 | 5 | 112 |

## Table LXIV.

Resistance to rupture of prisms of different mortars—made with natural hydraulic pastes.

| Nos. in the series. | Nature of the hydraulic paste used in making this mortar. | Age of the mortars or duration of immersion. | Fat limes and Hydraulic lime. | Hydraulic cement and lime cement. | Silecious Sand from Givors. | Weights that caused the rupture. |
|---|---|---|---|---|---|---|
| | Hydraulic Limes. | | | | | lbs. |
| 1 | Lime from Chanay near Macon | 4 mo. | 1 | 0 | 2.00 | 39.6 |
| 2 | do. Sury (Loire) | do. | 1 | 0 | 2.00 | 66.0 |
| 3 | do. Theil (Ardèche) | do. | 1 | 0 | 2.00 | 469.0 |
| 4 | do. | 1 mo. | 1 | 0 | 1.00 | 75.0 |
| 5 | do. | do. | 1 | 0 | 1.50 | 81.0 |
| 6 | do. | do. | 1 | 0 | 2.00 | 66.0 |

Table LXIV.—Continued.

| Nos in the series. | Nature of the hydraulic paste used in making the mortar. | Age of mortar or duration of immersion. | Fat lime and Hydraulic lime. | Hydraulic cement and lime cement. | Silicious sand from Givors. | Weights that caused the rupture. |
|---|---|---|---|---|---|---|
| | Hydraulic limes. | | | | | lbs. |
| 7 | Lime from Theil (Ardèche) | 1 mo. | 1 | 0 | 2.50 | 68.2 |
| 8 | do. | do. | 1 | 0 | 3.00 | 66.0 |
| 9 | do. | do. | 1 | 0 | 3.50 | 63.8 |
| 10 | do. | do. | 1 | 0 | 4.00 | 69.4 |
| 11 | Saint-Leger cement, near Châlons-sur-Saône | 4 mo. | 0 | 1 | 2.00 | 160.6 |
| 12 | Pouilly cement | do. | 0 | 1 | 2.00 | 297.0 |
| 13 | Marl from Givors, alone | 1 mo. | 0 | 1 | 2.00 | 50.6 |
| 14 | do. and fat lime | do. | 1 | 1 | 3.00 | 88.0 |
| 15 | do. | do. | 1 | 1 | 1.00 | 105.6 |
| 16 | do. | do. | 1 | 1 | 1.20 | 101.2 |
| 17 | do. | do. | 1 | 1 | 1.40 | 121.0 |
| 18 | do. | do. | 1 | 1 | 1.60 | 138.6 |
| 19 | do. | do. | 1 | 1 | 1.80 | 107.8 |
| 20 | do. | do. | 1 | 1 | 2.00 | 136.4 |
| 21 | do. | do. | 1 | 1 | 2.20 | 118.8 |
| 22 | do. | do. | 1 | 1 | 2.40 | 134.2 |
| 23 | Marl from Givors, alone | do. | 0 | 2 | 1.00 | 224.4 |
| 24 | do. | do. | 0 | 3 | 2.00 | 94.6 |
| 25 | do. | do. | 0 | 6 | 5.00 | 44.0 |
| 26 | do. | do. | 0 | 1 | 3.00 | 37.4 |
| 27 | Marl from St. Just, and fat lime | 4 mo. | 4 | 6 | 20.00 | 143.0 |
| 28 | do. | do. | 5 | 5 | 20.00 | 92.4 |
| 29 | do. | do. | 6 | 4 | 20.00 | 77.0 |
| 30 | Marl from Aubigny, alone, | do. | 0 | 1 | 2.00 | 35.2 |
| 31 | do. and fat lime | do. | 1 | 9 | 20.00 | 70.4 |
| 32 | do. | do. | 2 | 8 | 20.00 | 74 8 |
| 33 | do. | do. | 3 | 7 | 20.00 | 125.4 |
| 34 | do. | do. | 4 | 6 | 20.00 | 173.8 |
| 35 | do. | do. | 5 | 5 | 20.00 | 94.6 |
| 36 | do. | do. | 6 | 4 | 20.00 | 70.4 |
| 37 | do. | do. | 7 | 3 | 20.00 | 101.2 |
| 38 | do. | do. | 8 | 2 | 20.00 | 37.4 |
| 39 | do. | do. | 9 | 1 | 20.00 | 52.8 |
| 40 | do. | do. | 5 | 5 | 15.00 | 121.0 |
| | Lime cements and clay cements mixed with the ferruginous mineral. | | | | | |
| 41 | 9 of clay and 1 of the mineral | do. | 4 | 10 | 14.00 | 583.0 |
| 42 | 8 do. 2 do. | do. | 4 | 10 | 14.00 | 294.8 |
| 43 | 7 do. 3 do. | do. | 4 | 10 | 14.00 | 242.0 |
| 44 | 6 do. 4 do. | do. | 4 | 10 | 14.00 | 134.0 |
| 45 | 5 do. 5 do. | do. | 4 | 10 | 14.00 | 224.4 |
| 46 | 4 do. 6 do. | do. | 4 | 10 | 14.00 | 319.0 |
| 47 | 3 do. 7 do. | do. | 4 | 10 | 14.00 | 145.2 |
| 48 | 2 do. 8 do. | do. | 4 | 10 | 14.00 | 127.6 |
| 49 | 1 do. 9 do. | do. | 4 | 10 | 14.00 | 105.6 |
| 50 | Fat lime and Bedouan clay | do. | 4 | 10 | 14.00 | 732.6 |
| 51 | Lime and clay from Rive-de-Geir | do. | 4 | 10 | 14.00 | 642.4 |
| 52 | Mortar from a Roman aqueduct | 18 cen. | | | | 519.2 |
| 53 | Prism of burnt earth | | | | | 293.8 |

(TO BE CONTINUED.)

FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

## *New mode of obtaining Metallic Osmium.* By PROFESSOR ELLET.

The residue of the ore of Platinum after the action of the nitro-muriatic acid, and which consists principally of osmium and iridium is to be intimately mixed with an equal weight of chlorate of potassa, and the mass introduced into a green glass retort. On the application of a heat approaching to redness, the mass becomes suddenly ignited and a torrent of mixed oxide of osmium and free oxygen passes over. If the neck of the retort be inserted in a deep vessel of strong liquid ammonia, an *osmiate of ammonia* is formed and remains in solution, while the excess of oxygen escapes in bubbles. The solution of osmiate of ammonia by careful evaporation yields an imperfectly crystallized mass of prisms of a brown colour. These are to be introduced into a glass tube closed at one extremity and exposed in the flame of a spirit lamp, to a temperature of 400° to 500° Fahr. The mouth of the tube should be closed by the thumb. Decomposition ensues, the hydrogen of the ammonia decomposing the oxide, with the evolution of aqueous vapour and nitrogen gas, which is instantaneous, and is remarked by a sensible pressure on the thumb. The residual solid contents of the tube will be pure metallic osmium—in the form of a black powder.

If it be desired to exhibit the metallic lustre of the osmium, we may introduce a portion of the ammoniacal osmiate into a very small retort, pour upon it an excess of sulphuric acid—and apply a moderate heat. Osmic acid will be volatized. If now a stream of hydrogen gas be introduced into the neck of the retort, so as to blend with the osmic acid vapors, and the neck be heated to redness by means of a Cooper's lamp, reduction takes place, and a crust of metallic osmium, having the lustre and brilliancy of silex, lines the tubes

*South Carolina College, Columbia, S. C. May 7th,* 1838.

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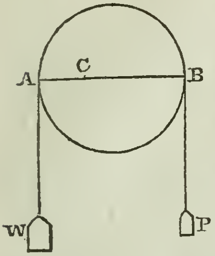
FOR THE JOURNAL OF THE FRANKLIN INSTITUTE.

## *The following remarks, on a subject recently discussed in the Journal, are offered for insertion, by* TROCHILIA.

The method by which some writers explain the properties of the pulley, regarding it as a lever of the first or second order, and which has been insisted on, in a late number of the "Journal," will appear upon a slight examination, to be unfounded, and to lead to false results.

The method in question is unfounded, because, it supposes a power applied, where, aside from the consideration of friction, none exists. A rope moving in the groove of a pulley exerts no tendency to turn it on its axis, except what arises from friction,—the very defect of the instrument which the pulley, properly so called, is intended to obviate. The mistaken notion that the pulley, like the wheel and axle, is only a modification of the lever, has evidently arisen from the fact that the pulley actually turns, and that one extremity of its horizontal diameter does, in the movable pulley, for an infinitely small portion of time, move through twice the space passed over by the weight attached to the centre, while the other extremity of the diameter remains for an instant stationary; indeed, inasmuch as the pulley turns on its axis, *it is a lever*; but the power applied to it, is not that which raises the weight, but only that portion of it which is lost in consequence of friction; and since the theoretical consideration of a mechanical power should have no reference to friction, it is plain that the idea of a lever should be excluded from our reasoning upon the pulley.

Let us suppose a pulley to be so constructed that its centre of gravity shall be at C; A, C, being supposed half of B, C, and let C, be the centre of motion of the pulley,—then, if the lever principle is applicable, a weight W, of two pounds, and a power P, of one pound should be in equilibrium: but the fact evidently is that W, would descend in consequence of the excess of its gravity over that of P. Disregarding the weight of the string, the centre of gravity of the system composed of the pulley, the power and the weight would evidently be in the vertical line drawn through C, and this being the case, there would be no tendency in the pulley to change its position during the descent of W, except so far as it would be affected by friction;—indeed any motion of the pulley must necessarily throw the common centre of gravity of the weight and power out of the perpendicular line in which it will descend if the pulley remain stationary.



I have confined my remarks to the fixed pulley for the sake of simplicity, but the same objections to the assumption of the lever principle, will apply in whatever form the pulley may be used.

## Mechanics' Register.

LIST OF AMERICAN PATENTS WHICH ISSUED IN AUGUST, 1837.

*With Remarks and Exemplifications by the Editor.*

235. For a machine for *Spreading Adhesive and other Plasters;* B. Morison, Milton, Northumberland county, Pennsylvania, August 8.

A metallic trough is made, which has two sides sloping towards each other at bottom, but they do not meet, the bottom being open for the length of the trough. This trough fits on to a metal roller, which may be about five inches in diameter; below this there is a wooden roller upon which the cloth to be spread is wound. The outer end of this cloth is to be passed between the metal roller and the trough, which are secured at such distance apart as to allow for it, and for the thickness to be given to the plaster; this latter is to be brought to a semi-fluid state by heat, and poured into the trough. It is then drawn out by an assistant, whilst another turns a winch upon the axis of the metal roller, to cause the cloth to pass readily through; this unwinds the cloth from the wooden roller, which is kept from too free a motion by corks bearing against its gudgeons. The claims made include the general structure of the machine as described.

236. For an improvement in the *Rotary Steam Engine;* Ashur Miller, Lockport, Niagara county, New York, August 8.

The nature of the invention, we are told, "consists in a revolving piston, and in applying the steam thereto by means of a side pipe, eccentric, or cam, and shifting or slide valve, as ordinarily applied to a reciprocating engine, thereby giving the piston a perfect rotary motion; which may be constructed on the high or low pressure principle." The patentee says that his engine "will be recommended by its simplicity. It will require less machinery than engines now in use, and thus avoid much friction. And the inventor believes it will give more power with the same quantity of steam than any engine now in use. Another advantage gained over the common reciprocating engine is the continued, constant, and equal, pressure of the steam upon the piston in one direction, thus avoiding those dead points at which, in the common reciprocating engine, foreign aid is required to start it." The claim is to "the combination of the shifting or slide valve with the rotary piston, as in the above specification."

This engine is, in general, the counterpart of some which have long been in the field, or rather on the shelf. The revolving piston has nothing new in it, but in the side pipes and slide valve there may, and it is believed there is, novelty, but unaccompanied by any thing tending to remove the faults which have consigned a host of rotary engines to oblivion. The slide valve, on the top of the engine, is to admit steam alternately into two hinged valves, placed opposite to each other; but what better effect this is to produce on the revolving piston we cannot perceive. The slide valve and its appurtenances do not, certainly, simplify the arrangement, and ought therefore to produce some substantial benefit. Should a condenser be added to work it on the low pressure principle, there would be another source of complexity, but scarcely of utility. Without hoping that there will, we are not prepared so say that there will not, be discovered a rotary engine of moderate power, and equally economical and durable with the reciprocating; but we have no hope that the one before us will take this station.

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237. For an improved mode of *Applying Warm Air to Fires;* John Silsbe, Tyrone, Steuben county, New York, August 8.

Whether this contrivance is for forge backs, for common fires, or for fires of all descriptions, we are not told. It appears, however, that there is to be a metal box, cast-iron we suppose, into which the air is to pass through a hole in the back plate, whether by blowing, or spontaneously, we know not. In the front plate there is to be a longitudinal opening, say five inches long, and half an inch wide, enlarging inwards. Three plugs, or stoppers, ranged side by side, are to close these openings if required. Three rods cross the interior of the box, and pass through the back plate, to govern the three stoppers. The mouth piece is made separate from the box, so that it can be renewed. We have told all.

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238. For a *Substitute for Gum Senegal;* Walter Leversidge, Dorchester, Norfolk county, Massachusetts; Patent issued in August, but dated May 30. (See Specification.)

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239. For a machine for *Riving, Planing, and Jointing, Shingles;* Enoch R. Morrison, Pittsburgh, Alleghany county, Pennsylvania; issued in August, but dated June 15.

There is considerable novelty in the arrangement of the respective parts of this machine, although all the operations intended to be performed by it have been previously performed by means not differing essentially from those described; in the claim, therefore, the arrangement and combination described are the points upon which dependance is placed. There is an apparent complexity in the machine, but probably not more than is necessary where the three operations of riving, planing, and jointing are to go on simultaneously.

240. For an improvement in *Grates and Stoves;* Edward H. Dixon, New York, August 8.

The fire place, under the arrangement proposed, is to be enclosed by sliding doors, glazed, or furnished with plates of mica. In the drawing, these doors are represented as sliding into jambs in the form of Gothic towers. The claim is to the combination of the glass, or mica, door, (as applied to grates and stoves) sliding on rods or flanches, either vertically, entire, or divided, and received behind the towers on either side the fire, substantially as described; together with the pipes and valves, as arranged with the various parts together as described, to attain the effect of warming the apartment, with constant ventilation, preventing currents of air, and the escape of gas and ashes into the apartment."

Such an affair may be made to look very pretty, undoubtedly; but the enclosing the fire by means of sash will scarcely be found economical or convenient. More of the heat will be carried off by the draught, and less be diffused by radiation, we apprehend, than from an ordinary open fire; this opening and closing of sash, whenever the fire requires attention, will also be a trial of patience both to the idle and to the industrious, although from different considerations.

241. For improvements in the common *Crank Power Loom;* Enoch Burt, Manchester, Hartford county, Connecticut; Patent issued in August, but dated February 10.

The patentee claims a particular mode of moving the shuttle box by a curvilinear cam co-operating with a horizontal lever and perpendicular rod. A particular apparatus for varying the figure is also claimed; and two modes of forming what is denominated a thread protection; which are contrivances for causing the power loom to stop when a thread breaks; by one of these the shuttle is prevented from boxing by the breaking of the bobbin thread, or from the bobbin being spent. We cannot give a description of these plans without engravings; nor could it be briefly done even with these aids.

242. For improvements in *Cooking Stoves;* Samuel Utter, City of New York, August 8.

The claim in this stove is to "the construction of a heated air chamber under, and at the ends of, the oven of a cooking stove; which chamber is unconnected with the flues that pass over or around the oven; and which air, when heated by the fire in the stove, or grate, is admitted freely into the oven through openings made in the bottom plate thereof for that purpose." The construction of a chamber for heating air is not claimed "excepting in connexion with the openings in the bottom plate of the oven through which it is to pass, this being its sole use."

243. For an improvement in the machine for *Teazling, or Napping, Cloth;* Benjamin Swazey, Mount Pleasant, Maine, August 8.

The claims made under this patent refer to a mode of fixing the teazles on wires, on the napping cylinder, and to a particular mode of fixing springs in the cloth rolls, and of throwing the rolls in and out of gear, keeping it in contact with the teazles as it is wound forward, and removing it as it is wound backward.

244. For *Stoves for Cooking;* James Wilson, City of New York, August 15.

The claims to the respective parts of this stove are of considerable length, and need not be given, as they relate to the particular modes of constructing, arranging and combining, plates, dampers, and flues in the way shown in the drawings.

245. For improvements in *Machinery for Doubling and Twisting Sewing Silk, Worsted, Cotton and Linen Thread;* John Golding, Dedham, Massachusetts, August 15.

The claim made is to the arrangement of machinery which by the breaking of the thread stops the spindle, and throws the feeding-down-roller up, and prevents the thread from running to waste.

246. For a *Safe for the Preservation of Papers,* which can be used as a writing desk; Daniel Fitzgerald, city of New York, August 15.

A case of sheet-iron lined with some bad, and incombustible, conductor of heat, is fixed beneath a table, or desk; the top of this box is open, and it is to receive a case, made of similar materials, for containing books and papers. This latter case is made to descend into the former, or to be raised from it, by a windlass and chain. When up, it forms a part of the writing desk, and when down, its top forms the cover ot the case first named, and is flush with the table part of the desk. When the safe is raised, its doors, which are hinged at their bottom edges, fall, and form the table to write on. The claims are to the "forming a writing table of the door of the safe, or raising chest, or case. The combination of safe and desk, or writing table."

We cannot well conceive of a less promising affair than the foregoing, which could pass examination in the patent office; but things are not stopped there merely because they are trifling, provided they present any novelty and do not violate the known laws of mechanical, or of chemical philosophy. The iron part of the above described instrument is, at best, but a small iron chest, or safe, without the pretence of any new means of safety from fire.

247. For an improved *Smut Mill;* Charles D. Childs, Mount Morris, Livingston county, New York, August 15.

The outer shell of this smut mill has the general form of a vertical cylinder, but consists of separate rings piled one above the other, the lower edge of an upper, entering within the upper edge of a lower ring, throughout the series, there being an open space left between each ring for the passage of air and dust. The inner sides of these rings are surrounded by five vertical flutes. Within the body thus formed, there is a revolving cylindrical rubber, consisting also of sections of metal, covered with teeth, and approaching the inside of the outer shell. There are protuberances of this revolving part which agitate the grain as it passes down from the feeding hole in the upper plate of the machine. The claim is to "the manner of forming and combining the cast-iron rings; leaving the annular openings for the escape of air, dust, and smut; and the manner of constructing and using the revolving fluted rasps, formed and operating as described."

248. For a *Press for Pressing Cheese and other Articles;* Sullivan White, Bridgewater, Windsor county, Vermont, August 15.

In Vol. XVI. p. 174, there is an engraving and description of a self-adjusting cheese press. That now before us is also upon the self-adjusting principle, in which the weight of the article to be pressed acts in producing the pressure, but there is considerable difference in the arrangement of the parts. The claim made is to "the arrangement and combination of friction rollers, levers, and sliding frame, by which the weight of the sliding frame, cheese, and if necessary, other weights, causes the action of the levers to be such that their power is increased in proportion to the descent of the sliding frame, so as to secure an adequate pressure at the commencement of the operation, and an increasing power in proportion to the ascent of the sliding frame; thus applying the power when and where most required."

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249. For a *Machine for Cutting Shingles and Siding from Steamed Timber;* Joseph S. Raymond, Lodi, Cattaragus county, New York, August 15.

A wheel is to be made of about eight feet in diameter, and this is to revolve vertically on its axis. Two knives are placed on one face of this wheel, of such length as may be required by the shingle to be cut. These knives are opposite to each other, extending from near the periphery towards the centre of the wheel. They are distant from the wheel so far as is required for the thickness of the shingle, and the distance varying at the two ends according to the slope of the shingle. They stand in reversed positions in this last respect, one of the knives cutting the thick, and the other, the thin, end of the shingle towards the periphery of the wheel. The shingles as they are cut pass through openings in the wheel, in the manner of the throat of a plane. The stuff is laid upon a bed and fed up by the action of weights. The bed is made to vibrate by projecting, inclined pieces on the face of the wheel.

The claims are to the reversed position of the knives; the manner of vibrating the bed upon which the stuff lies; and to a lever and knife for edging. The cutting by knives on the face of the wheel is disclaimed, as not being new, leaving the features of novelty not of a very prominent character.

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250. For an improvement in the construction of *Rain Water Cisterns*; George W. Blenis, Salina, New York, August 18.

The cisterns, of hydraulic lime, are to be constructed with their bottoms in the form of an inverted dome, in situations where the soil is wet, to enable them to resist the upward pressure of the external water.

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251. For a *Mode of applying a compound resinous Cement in making Cisterns, Reservoirs, Piers, &c.;* Thomas Coyle, Baltimore, August 18.

There is no novelty in the composition of this cement, which is formed of one part of rosin and two parts of dried clay finely pulverised. These are to be incorporated in a kettle, over a fire, and heated until of a dark brown colour, when it will become so tough as not to crack in the cold, and so hard that the heat of the sun will not make it soft. The specification describes the mode of applying it to the walls and floors of cellars, to reservoirs, &c., and then adds, "although I have described the manner of using and applying this cement for various purposes, I wish it to be distinctly understood that I do not claim to be the inventor of the cement itself, or of its application to keep out moisture in cellars, vaults, &c.: nor do I claim the application thereof to such purposes in a heated state, this being necessary in all cases, and a thing well known. But what I do claim as my discovery is the applying it, (in places, or vessels, which contain water,) so highly heated as that it shall expel the moisture therefrom, so as effectually to adhere to pebbles, stones, wood, and other substances with which it comes into contact."

It is proposed to form piers, or columns, in water, by filling a box, or casing, with stones, and then pouring in the cement in a highly heated state, which it is averred, will disgorge the water, and heat the stones, so as to secure perfect adhesion, and great solidity in the mass.

252. For an improvement in the *Strainers for Milk Pails;* Isaiah Bunnell, Darby, New Haven county, Connecticut, August 18.

The lip, or spout, of a milk pail, instead of being punched full of small holes in the usual way, is to have a piece of wire gauze soldered in its place. "This pail is used for milking, and the milk is perfectly strained by simply pouring it through the spout into the receiving vessel."

253. For an improvement in the mode of constructing *Paddle Wheels for propelling boats, &c.;* John S. Greenough, Boston, Massachusetts, August 18.

"This wheel consists of an axle, arms, buckets with cranks, balance or guide wheels, latch bolts for bracing the buckets in their proper position, with lifters or followers for raising the latch bolt, and returning it to its place again, and friction wheels to confine the guide wheels in their place. The improvement here claimed is the manner in which the buckets are kept parallel, and either vertical, or at any angle, as deemed most efficacious in propelling."

A host of wheels have been contrived with a view to giving the paddles a vertical, or nearly vertical, position; and many of them have been tried at great expense, and have been abandoned; boats have been kept running for a considerable length of time with such wheels, with no other discoverable advantage than by more frequent want of repair, affording employment to the workman: one, or more, is now on trial in Europe, and flattering accounts of advantageous results have been received, but we are incredulous, and will not admit the testimony until it has been confirmed by time. The plan before us does not differ in principle from that adopted by others, but the mode of arrangement is varied, and for this the patent is taken. There have been some more simple, and some more complex; the particular difference between this and other members of the vertical paddle family, cannot be made clearly known without a full description and drawings, and these we promise as soon as it goes into successful operation.

254. For an improved mode of applying the *Bow and Worm Spring to Saddles;* Jonathan Keedy, Russelville, Logan county, Kentucky, August 18.

In the kind of spring applied to the saddle, as described in the specification, there is no claim made to novelty, but only to the manner in which it is arranged; which, however, does not present any thing of apparent importance.

255. For improved *Tongs, or Grappling Irons, for raising bodies from under water;* Ebenezer and Thomas J. Lobdell, city of Boston, Massachusetts, August 18.

These grappling irons are constructed in several different modes, according to the nature of the article which they are intended to raise; those for bars of iron, for example, differing in certain points from such as are to take hold of large stones; the principal novelty about them consists in the addition of wings, or bearing frames; and these constitute the claim. We shall not attempt to describe the various forms of the instrument, for although there may be some novelty in them, it is not to be supposed that, in the numerous cases where such things have been required and used, they have not been differently constructed and adopted to the object in view.

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256. For improvements in *Wind Mills;* Ebenezer Sperry, Wenham, Essex county, Massachusetts, August 31.

In this wind-mill the power of the wind is to be obtained in a square building, or tower, which may be from ten to fifteen feet square, and from fifteen to twenty feet in height, and this is to be enclosed at its base by eight doors, through which the wind is to be admitted, and by which its force is to be regulated. There are to be partitions, or wing walls, extending out between these doors to catch and condense the wind. Within this building there is to be a vertical shaft, from which successive circles of arms are to proceed, one above the other, like the spokes of a wheel; of these circles there may be four, five, or more; to the arms are attached vanes, or oblique wings, standing in the position of the vanes of a common ventilator. These circles of vanes are to increase in diameter as they rise one above the other. In the drawing, the tower is represented as roofed in, and having openings on each side containing blinds. The claims are to,

1st. The aforesaid construction and arrangement of buildings, or of more simple and less expensive structures, presenting, in the manner aforesaid, an extended surface, for the purpose of condensing and concentrating the currents of air, and throwing the whole force thus concentrated and condensed, directly upon the arms of the wind-mill.

"2nd. A series of arms on the same vertical shaft, or axis, which, while they receive the whole power of the air condensed and concentrated in the manner and by the means aforesaid, operate so as, in a great measure, to equalize the action of said power, while, at the same time, by means of their peculiar structure as aforesaid, they present as little resistance to the air as possible.

"3rd. The means used for letting off an excess of wind, by waste gates and doors, and for increasing its power by the use of canvas, or sail cloth, or other suitable materials."

To a mill of this construction, the objections appear to us to be numerous, and of such a nature, as seem well calculated to render this uncertain power less efficient than in mills of the ordinary construction. The attempts at giving to wind-mills a form and arrangement which shall render this power more available than in the Dutch mill, have, we believe, been in all instances a failure. Such we know has been the case with the horizontal mills, generally, and these, we apprehend, are the second best. In applying fluids to move machinery, there is much loss of power from sudden and great changes of direction, and in the mill before us this objection is very far from being removed.

257. For *self-loading and priming Fire Arms;* Silas Day, city of New York, August 31.

It is not necessary to give the claims in the present case, as these would afford no information respecting the construction of the parts referred to in it; nor do we think it necessary to attempt a description of an arrangement which we apprehend will share the fate of nine-tenths of the improved fire arms, which now stand upon the lists of the Patent Office.

258. For an improvement in *Ship Building*; Samuel E. Howell, Vincent town, Burlington county, New Jersey, August 31.

The claim is to "the forming the bows of vessels of a large class, in a regular curve; without a cut water, and in forming the keel in the section of a cone." What is meant by forming the keel in the section of a cone, is, that it flares out on each side, so that it is considerably wider at its lower side, along its whole length, than it is where it joins the bottom of the vessel. The advantages assigned to a vessel constructed with a bow of a regular curve, and without a cut water, are, that she will answer more readily to her helm, and will bear more beam than one with a sharp bow; that her greatest breadth of beam may be far forward, which will give her a larger sailing floor: that she will turn to windward more readily than a sharp ship; will ride at anchor much easier; will not gripe, or shear; will bear to have her masts without rake, and that the sails will consequently set more fair to the wind. The advantage of the form of keel described, is said to be that when the ship keels over with the wind, the lee side will present a perpendicular side to the water, which will hold the better to windward; a few additional inches to the width of keel making up for the deficiency of the cut water to the forward keel. Let nautical men judge of all this.

259. For a *Quadrant Hinge for Stoves*; Ebenezer Barrows, Boston, Massachusetts, August 31.

This is a very convenient affair for oven doors, the doors falling down, and presenting a useful horizontal hearth. The claim is to "the contrivance or structure described, as resembling the quadrant, somewhat, in form, applied to the purpose described. Also the improvement whereby the hinge is cast in one piece with the door leaf, or damper; requiring only a mortise or jog in the door frame, to complete the hanging of the door-leaf, or damper. Also the combination of the above description of hinge with the improvement of casting it in one piece with the door-leaf, or damper.

260. For an improved *Yoke for Horses or Oxen*; Gideon Hotchkiss, Windsor, Broome county, New York, August 31.

Should farmers in general adopt the yoke which forms the subject of this patent, the gratitude of the patient ox, will be fairly due to Mr. Hotchkiss. As yokes are generally made, it would seem that the same judgment had dictated their form which induced the Hibernian to declare that it was the nature of the beast to pull by the tail. This yoke is suspended and turns on pivots in a way which causes it to adapt itself perfectly to the motions of the animal. The claim made, is to "the manner of combining the part which constitutes the collar, in the yoke described, with the branched yoke, or with the cross bars, by means of pivots, as set forth.'

We have seen a yoke very nearly resembling this, described in a French work on agriculture; but the two are not identical.

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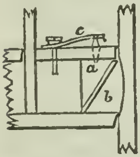
261. For an improvement in the mode of *Packing the Pistons of Steam Engines*; John Williamson, city of New York, August 31.

The piston is to have a cylindrical body, small enough to allow room for packing between it and the cylinder, plates of metal covering the upper and lower sides thereof, of such diameter as to fit the cylinder. Around the piston, between the two plates, there is to be a hoop of copper, the diameter of the upper edge of which is such as to extend to the cylinder, whilst its lower edge is in contact with the solid body of the piston, this hoop, therefore, being in the form of the frustrum of an inverted cone; it is cut through from bottom to top, to allow it to expand. A space *a*, will thus be left between the body of the piston and the copper hoop, and a space *b*, between the copper hoop and the cylinder, both of which spaces are to be packed in the ordinary way. Springs *c*, attached to the upper plate, press upon pins which communicate their bearing on to the packing in *a*.



The claim is to the combination of the conical hoop; the springs, packing rings, &c. with the other part of the piston, not being claimed as new.

The above arrangement does not appear to offer any thing superior to some other plans for giving elasticity to the packing of pistons.

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262. For a *Press for Hay, Cotton, &c.;* Jacob Grosvenor, city of New York, August 31.

In this press "the weight and accelerated gravity of a falling body are used to effect the compression of hay, cotton, hemp, or other similar substances. Such arrangement being used, when needful, in combination with a lever, in the form described, so as to diminish the length between the fulcrum and the working point of the lever, and thereby give an increase of power to the lever when the resistance is greatest." Such are the points claimed. A heavy follower, having a vertical rod extending to a considerable height above it, is to be raised by means similar to those used in raising the ram of a pile driver; and this is to be let fall upon the cotton, hay, &c. contained in a high vertical box; after which the follower is to be forced down by levers as indicated.

The idea of packing elastic fibrous material by means of a ram, is, we believe, new, and we also believe that it will be found to be worse than useless, as we do not entertain the slightest doubt that the time and power expended in raising the ram would effect twice as much in the process of packing in well known ways, as will be effected by the falling of the ram.

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263. For an improvement in the *Cooking Stove;* John S. Leavitt, Turner, Oxford county, Maine, August 31.

The claim is to "the combination and adoption of an open fire place with a cooking stove, having a furnace, oven, boilers, holes, &c. substantially as described:" which combination and arrangement differ sufficiently to sustain the claim for a patent; but as to points of superiority, we have nothing to say, as the drawing and description do not render their existence very manifest.

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264. For *Manufacturing Hydraulic Cements;* Ebenezer C. Warner, city of Albany, New York. Patent dated October 6th, 1837. (See Specification.)

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265. For a *machine for Sowing and Spreading Lime, Plaster, &c.;* Levi Rice, West Chester, county of West Chester, Pennsylvania, August 31.

A circular, revolving table, or platform, is placed horizontally under the bed of a cart, at its rear end. It is made to revolve by a shaft connecting it with one of the driving wheels; a man in the cart, with a shovel, or otherwise, causes the article to be disseminated to pass through a hopper, or opening, upon the revolving table, whence it is thrown by the centrifugal force derived from its rapid motion.

The claim is to "the application of the centrifugal force to disseminate lime, plaster, &c. and small grain, in the manner described."

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266. For an improvement in the *Machine for separating Smut from Wheat;* and for cleaning all kinds of small grain; Benjamin M. Smith, Rochester, Monroe county, New York. Patent dated August 1st.

The claim is as follows: "what I claim as my invention is the constructing a machine for cleaning wheat, or other grain, having a shaft with revolving disks, the upper surfaces of which are made rough by punching, or otherwise; which disks are surrounded by a case, the interior of which is also made rough by punching, and the insertion of metallic points in alternate sections, the whole constructed as set forth; also the vanes as combined with this machine, and the particular manner of forming the step."

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## SPECIFICATIONS OF AMERICAN PATENTS.

*Specification of a patent for the manufacture of a Substitute for Gum Senegal, to be used in calico printing, and other processes; granted to* WALTER LEVERSIDGE, *Dorchester, Norfolk county, Massachusetts. Patent dated May 30th,* 1837.

To all whom it may concern, be it known, that I, Walter Leversidge, of Dorchester, in the county of Norfolk, and State of Massachusetts, have invented certain new and useful materials, prepared by a process herein described, and also a new and useful composition of matter, to be used as a substitute for gum senegal, and other articles of a similar nature, employed in calico printing; which composition of matter, when prepared for the calico printer, I denominate "factitious gum senegal powder," and I do hereby declare that the following is a full and exact description of the mode of compounding and preparing the same; and also of preparing a substitute for gum senegal from certain individual materials used in making the compound.

The composition consists of sago, potato starch, and lime, which may be combined together in variable proportions, but the best mixture is made in the following relative quantities, or nearly so. I take forty parts of sago, fifty-five parts of potato starch, and five parts of quick lime, which ingredients I mix together, and reduce the whole to a fine powder. I then put this powder into an open vessel, and expose it to a temperature not exceeding 220° of Fahrenheit's thermometer, keeping it at this temperature until it has parted with all the water which it will lose at that degree of heat, and until the mass has become slightly discoloured; to insure an equal action of the fire upon the mass, the vessel must be so constructed as that its contents may be stirred, or agitated, during the process of desiccation. The vessel is then to be closed, leaving only a small aperture through which the acid and other vapours may escape, and through which the powder may be examined by the aid of a small spatula, to ascertain the progress of the operation. The heat is to be gradually raised until it approaches a temperature of 620°; this part of the operation requiring from three and a half to four hours, or a length of time sufficient to produce the proper colour, which is a dark orange brown.

The vessel is then to be uncovered, and the contents mixed intimately by stirring; it is then to be closed, and a stopper put into the small hole left for the escape of the vapours, and the heat continued as before, but not increased in any sensible degree; a reaction of the materials now takes place, the mass becomes somewhat adhesive, and exhibits an appearance of partial fusion. This is ascertained by occasionally removing the stopper, or inserting the spatula, when a portion of the mass will adhere to it. It is now to be removed from the fire, spread out thinly on a floor, stirring and turning it until it becomes cool. After this it is again ground, and passed through a fine sieve, or bolting cloth. The material is then ready for the calico printer, and is used for the same purposes, and in the same way, as the native gum senegal.

I sometimes use the potato starch, without the admixture of sago, or of lime, and I likewise sometimes employ the sago alone, treating them in the same way with the above named compound, and by this means produce a material which, although not equally good for all purposes as a substitute for gum senegal, will answer in some cases, and has not, to the best of my knowledge and belief, been heretofore applied to this purpose.

What I claim as my invention, and wish to secure by Letters Patent, is the preparing a substitute for gum senegal or other gums of a similar nature, by the calcination or roasting, of a compound of sago, potato starch, and quick lime, either in the proportions designated, or in any other proportions by which a substance substantially the same is obtained.

I also claim the preparing of a substitute for gum senegal, or others, &c. in some respects analogous to the foregoing compound, by the calcination or roasting of either sago, or potato starch alone, or in variable proportions, with or without the addition of lime.

WALTER LEVERSIDGE.

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*Specification of a patent for an improved mode of protecting the Metallic Sheathing of Vessels; granted to* EDWARD M. ROBINSON, *New Bedford, Bristol county, Massachusetts, August 8th,* 1837.

Be it known that I, Edward M. Robinson, of New Bedford, in the county of Bristol, and State of Massachusetts, have discovered a new and useful improvement in the art of preserving copper, or other metallic, sheathing, from corrosion and waste, when applied to the sides and bottoms of ships or vessels; and I do hereby declare that the following is a full and exact description of my process.

Take of paint by grinding pure verdigris in linseed oil, and diluted to a proper consistence to be applied to the sheets of metal, with a mixture of one gallon of linseed oil, and half a pint of a lacker prepared as follows: viz. by boiling together seven and a half gallons of linseed oil, four pounds of shellac, four pounds of red lead, and four pounds litharge until the shellac is dissolved.

Apply this paint with a brush to both sides of the sheet of copper or other metal intended to be used, and when dry, add one or more coats as may be desired. If it is wished that the paint should dry very rapidly, half a pint of spirit of turpentine may be added to every gallon of oil used in diluting the paint. When the paint is perfectly dry and hard, the sheets may be fastened upon the vessel's bottom in the usual manner. This paint may also be applied to metallic sheathing after it has been placed upon the bottoms of vessels; and it may also be applied to but one side of the metal before being fastened upon the vessel's bottom; but it is decidedly preferable to use it as first described.

What I claim as my discovery in the art of protecting the copper, or other metallic, sheathing of vessels from corrosion, is that by the application of a coating of paint, in which verdigris is the principal ingredient, to such metallic sheathing, in the manner above described. such protection will be effectually attained. I do not claim to be the inventor, or discoverer, of the above described paint, nor do I intend to limit myself to its application in the form prescribed, but to use verdigris mixed with oil, or varnish, in any of the modes in which a desirable paint is produced, in which the main body consists of verdigris, limiting myself to its employment for the purpose of protecting the metallic sheathing of ships, or vessels; such application being as I firmly believe new in the arts.

EDWARD M. ROBINSON.

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## *Specification of a Patent for the employment of the Mineral called Basanite, in manufacturing Hydraulic Cement; granted to* EBENEZER C. WARNER, *City of Albany, State of New York. Patent dated Oct. 6th*, 1837.

To all whom it may concern: Be it known, that I, Ebenezer C. Warner, of the City of Albany, in the State of New York, have discovered a new and useful mode of manufacturing Hydraulic Cement by the employment of the mineral called Basanite, Lydian-stone, and commonly called touch-stone. And I do hereby declare that the following is a full and exact description of my discovery.

The said material is to be burned in any convenient mass, in the manner of burning lime in kilns, in layers of wood and pit coal, with the mineral on the top, to a red heat, which may be continued six or eight hours.

After cooling, the said mineral is to be cracked, and then reduced to a fine powder, as impalpable as practicable. For this purpose it should be ground between stones of the ordinary size and kind, or any other process of pulverizing may be resorted to, by which the material may be reduced. This powder is to be mixed with water to a proper consistence for application to the purpose for which it is designed.

The said hydraulic cement, thus prepared, is similar in its qualities, and appliable to the uses of Roman cement (so called,) and being insoluble and indistructable in water, and capable of resisting the action of, and exposure to, frost; thus becoming a paste cement, or mortar, for laying stone which is to be exposed to the action of water; a cement for cisterns, aqueducts, and securing cellars, or other excavations, below the surface of the ground, which require to be secured against the admission of water.

The analysis of Lydian-stone as ordinarily found, is as follows:

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|---|---|
| Silex | 23. |
| Alumine | 15. |
| Potassa | 8. |
| Lime | .50 |
| Oxide of iron | 18. |
| Copper | 24. |
| Water, carbon and loss | 11.50 |
| | 100 |

What I claim as my discovery, and desire to secure by letters patent is, a new and useful mode of manufacturing hydraulic cement by the employment of the mineral called Basanite, Lydian-stone, and sometimes touchstone, as a principal ingredient therein. Ebenezer C. Warner.

## English Patents.

*Specification of a patent granted to* Fletcher Woolley, *for his invention of improvements in the manufacture or preparation of materials to be used as a substitute for bees-wax, parts of which improvements are applicable to other purposes.* Nov. 11, 1837.

The various substances employed in the different processes of this invention are comprehended under the following heads, and will be referred to in describing such processes numerically.

First, all kinds of animal and vegetable fats and oils, solid at the medium temperature of the surrounding atmosphere, which is about sixty degrees of Fahrenheit, as tallow and other animal fats, and palm oil, cocoa-nut oil, and other like vegetable oils commonly used for giving light by, or in, combustion. Second, all kinds of animal and vegetable elains and oils, liquid at the medium temperature of the surrounding atmosphere, as the elain of tallow, palm oil, cocoa-nut oil, seal, whale, sperm, and other oils used for affording light by combustion. Third, all kinds of naphtha, or coal, tar, oil, caoutchouc naphtha, or caoutchouc oil, gas oil, vegetable naphtha, or vegetable tar naphtha, and any other like naphthas or oils used as aforesaid, and commonly sold for that purpose. Fourth, pyroligneous naphtha or ether, correctly named pyroxylic spirit, sulphuric ether, and all other spirits or ethers of like nature. Fifth, all mixtures of the substances included under head the third, with those substances included under head the fourth, as two parts of coal naphtha or caoutchouc naphtha, with about six more parts of pyroxylic spirit. Sixth, resinous bodies and resins, as caoutchouc resin, mastic, copal, shel-lac, and others, and combinations of them with each other, as one part resin and four parts shel-lac melted together. Seventh, mixtures of the substances included under the heads third, fourth, and fifth, with the substances included under head the sixth, as thick solutions of copal in spirits, ethers, or naphthas, &c., and caoutchouc in naphthas formed by processes already known to the public. Eighth, certain solid bodies separated from solid animal and vegetable fats and oils, as stearine, stearic acid, margarine, and margaric acid, adipocere, and others of like nature. Ninth, mixtures of the substances included under head the second, with the substances included under heads third and fifth, or three parts of cocoanut elain to one of naphtha, or to two of the substances included under head the fifth.

Firstly, palm oil of commerce is to be put into a shallow vessel made of copper tinned, or iron or other suitable metals, and raised to the temperature at which incipient decomposition begins and vapour flies off, at which temperature it must be kept for upwards of half an hour, and then allowed to cool gradually and undisturbed; by which process the stearine will crystallize more perfectly, and separate better from the elain. When sufficiently cold and solid, or about the consistence of old honey, it is to be put into bags or wrappers made of strong linen or sacking, or other suitable material, of such size and in such quantity that each bag or wrapper when filled shall be about two feet long, one foot wide, and one and a half inches thick, and in this state subjected to the pressure of a powerful hydraulic screw, or other suitable press (a ten-inch hydraulic ram has been used.)

This pressure is to be increased very slowly and gradually, and the material kept as nearly as possible at the medium temperature of the surrounding atmosphere, as long as any elain continues to ooze, by which process the greater part of the elain will be pressed out from the stearine.

The elain thus obtained is applicable to the purposes of burning in lamps to give light, and of lubricating machinery; and the stearine thus produced may be made into candles or other useful articles, or manufactured into a substance to be used as a substitute for bees-wax, as hereinafter described.

Secondly, any of the substances included under head the first, are to be melted and mixed in the fluid state, with any of the substances included under the heads second, third, ninth, and fifth, in a suitable vessel, and in the proportions of three parts of the former to one of the substances under heads third, second, and ninth, or to thirty or forty parts of the substances included under head the fifth, or in any other suitable proportions determined by the dissolving strengths of the substances included under heads second, third, fifth, and ninth; and the solidity and less solubility of the substances included under head the first, for they must be mixed in such proportions that the mixture shall be nearly of the consistence of old honey, at the medium temperature of the atmosphere.

When thus mixed, the mixture must be allowed to cool gradually and undisturbed, to favour the more perfect crystallization of the stearine, and to facilitate the separation of the elain; and when cold, and of the consistence of old honey, or thereabouts, it must be put into bags or wrappers and subjected to pressure, as hereinbefore described; by which process the elain will be pressed out combined with its solvent, and the stearine will remain in bags or wrappers.

The stearine can be made into candles or other useful articles, or manufactured into a substance to be used as a substitute for bees-wax, as hereinafter described; and the elain combined with its solvents may be applied to the purposes of burning in lamps for giving light, and of lubricating machinery.

Thirdly, any of the substances included under head the eighth. of which those made from tallow are best, are to be melted and mixed in the fluid state with any of the substances included under heads sixth and seventh, also melted in a fluid state in the proportions of three parts of the former to one of the latter, or in any other suitable proportions, accordingly as the resulting compound to be used as a substitute for bees-wax is required more or less tenacious. For the smaller the proportion of any of the substances included under head the eighth, the stronger or more tenacious is the compound of the substances included under head the sixth; resin melted with four times its weight of shel-lac is best adapted.

It will also be well to state here, that shel-lac will not melt and mix with the substances included under head the eighth, unless previously united with the resin, mastic, or such like resin; and also that caoutchouc, copal, &c., will not unite well with the substances included under head the eighth, unless previously dissolved, as mentioned and contained under head the seventh.

Fourthly, any of the substances included under the heads third, fourth, and fifth, are to be mixed with any of the substances included under the heads second and ninth, in proportions varying according to the dissolving strengths of the former, or the soluble qualities of the latter, for the purpose of rendering the latter more liquid and better adapted for burning in oil lamps of common construction for the purpose of affording light.

Fifthly, any of the substances included under head the fourth, are to be mixed with any of the substances included under head the third, particularly coal, tar, naphtha, and caoutchouc naphtha, in the proportions of one part of the latter to three of the former, for the purposes hereinbefore mentioned, and for burning in common oil lamps to give light.

Journ. Arts & Sciences.

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## *Specification of a patent granted to* W. HEMPEL AND H. BLUNDELL'S *for preparing animal and vegetable substances for manufacturing Candles.*

This invention consists in operating upon palm oil, animal fat, or tallow and bees wax, in the manner and with the materials hereinafter set forth and explained, so as effectually to separate the stearine from the elain contained in the palm oil and animal fat or tallow, and convert the said stearine, by submitting it to the process of oxygenation, bleaching, and purifying, hereinafter described, into a highly improved stearic acid, which used by itself makes a very superior candle, or mixed with bees-wax enables candles principally made of that material to be run in moulds, instead of being dipped and rolled in the ordinary tedious manner.

As to the palm oil, the patentees say they subject this material to seven different processes—crystallization, pressing, oxydation or conversion of the stearine into stearic acid, separating the stearic acid from the lime, washing and pressing a second time, bleaching and refining.

First, crystallization; palm oil, as imported, is melted and run into large iron or other vessels, which are called crystallizing vessels; in these it is allowed to cool very gradually, the stearine crystallizes at a temperature of about seventy-five degrees of Fahrenheit, and the elain at this temperature partly separates from it.

Second, pressing; at about the last-named temperature, it is subjected to a powerful hydraulic or other mechanical pressure; the liquid part which runs from the press is the elain, and the solid substance which remains in the press is the stearine in an impure state, with a portion of margarine.

Third, oxydation or conversion of the stearine and margarine into stearic and margaric acid. The stearine and margarine are first melted in an iron vessel; to every 104 lbs. of the stearine and margarine, add, very gradually, 12 lbs. more or less, according to the quality of the ingredients, of very dry hydrate of lime in a very fine powder, keeping the mass briskly stirred during the whole time. The temperature is to be gradually increased to about 240 degrees of heat, and kept well stirred for about three hours, or until a perfect combination of the stearine and margarine with the lime takes place. This may be known by the mass becoming thin and transparent, and when cold, assuming a glassy appearance. This operation being finished, the fire is withdrawn, and cold water added very gradually at first, stirring very briskly all the while, until the whole mass falls into a state of coarse granulation, or powder; this is then passed through a wire sieve, to break down any lumps that may remain.

The patentees observe, that it may be as well to state how they prepare the said hydrate of lime, although this forms no part of the invention claimed. The lime-stone must be of the best quality, and free from flints: take pieces of such lime well burnt and fresh, lay them on a sieve, and immerse the whole in water for the space of one minute; take it out, and let the water that is not absorbed run off; the lime will soon fall to a powder; take this and put it into an iron vessel moderately heated, and covered down with a wooden cover, to drive away, by evaporation, any water that is free. It must then be passed through a fine sieve, and used as quickly as possible, as it soon attracts fresh moisture.

Fourth, separate the stearic and margaric acid from the lime. The stearine and margarine, by the last described process, has now become acidified or oxygenated in combination with lime, forming stearate and margarate of lime. Now proceed to separate the stearic and margaric acid from the lime. For this purpose muriate of lime is used, and sulphuric acid; take as much of the muriate of lime as will produce sufficient muriatic acid to decompose the quantity of stearate and margarate operated upon. To the muriate of lime, add as much sulphuric acid as will precipitate the lime and set the muriatic acid free. Put to the stearate of lime a sufficient quantity of this muriatic acid to dissolve all the lime contained in it, taking care to employ an excess of acid; the proportion will be about 3 lbs. of muriatic acid diluted with 9 lbs. of water to 1 lb. of lime.

This mixture is to lay three or four days, in order to ensure the complete solution of the lime; sufficient heat is afterwards employed to melt the stearic and margaric acids which then float on the surface. The muriate of lime is removed into another vessel, and decomposed with sulphuric acid; the disengaged muriatic acid is used in the next operation with stearate of lime, and so on. By this process the only expense of acid is the sulphuric, which is a saving of at least 50 per cent., with an almost perfect separation of the lime from the stearic acid.

Fifth, washing and pressing a second time. The stearic and margaric acids having been well washed with hot water, are again subjected to the press at a temperature of about seventy-five degrees of heat, to separate the stearic from the margaric acid.

Sixth, bleaching process. The stearic acid is taken from the press, and put upon water in large shallow vessels, placed in the open air, and kept at the melting point from eight to twelve hours, occasionally stirred, and exposed as much as possible to the action of the atmosphere, until it has become white. The margaric acid is bleached in the same manner, as above described, in separate vessels.

Seventh, refining process. It is then warmed again and removed in a melting state to a vessel which is called an agitating tub. To every 1000 lbs.

of stearic acid we use in this refining process 1 lb. of the black oxide of manganese, prepared from the white carbonate of manganese, or about $2\frac{1}{2}$ lbs. more or less, of the common black oxide of manganese, 40 lbs. of concentrated sulphuric acid, diluted with 200 lbs. of pure water; this solution, while warm from the heat which it evolves, is placed in a suitable vessel above the agitating tub; the stearic acid, being at the melting point in the vessel below the agitator or stirring shaft of this last named vessel, is set to work, and the solution is allowed to run gradually into it, until the whole is well mixed, which generally requires about two hours. The mass is allowed to lay in this state for forty-eight hours; it may then be boiled by steam for two or three hours, when it will be found to be sufficiently refined. The sulphuric acid which is at the bottom is now run off, and the stearic acid which remains is well washed with pure water; it is then put into large conical vessels of stone ware, enclosed in a box or jacket and kept warm by steam heat, and lined with conical bags of suitable strong, filtering paper, through which, being warm, it finds its way; and when the stearic acid has been thus filtered, it is run into blocks, when it will be found a beautiful stearic acid, which the patentees call palm stearic acid, or palm wax. It is then ready to be made into candles in the usual way.

Another mode is also proposed to be employed as a process of refining. To 100 lbs. of stearic acid add 16 lbs. of sulphuric acid, diluted with about 128 lbs. of pure water, or 21 lbs. of sulphate of manganese, and 9 lbs. of common salt. Boil these by steam for ten or twelve hours; or take about 10 per cent. of phosphoric acid, highly concentrated, or 10 per cent. of oxalic acid; boil in either case ten or twelve hours with steam. By using the phosphoric or oxalic acid, any earthy or metallic matters that might still adhere to the stearic acid, are effectually dissolved with more certainty than can be done by the agitator, unless the stirring shaft is very carefully and vigorously worked. And there is no extra expense of acids, as it is worked over and over again, being occasionally purified by the addition of a small quantity of sulphuric acid, which throws down any earthy or metallic matter the phosphoric or oxalic acid may have collected. The stearic acid, after having been well washed with pure hot water, is in this case also filtered as above, and run into blocks.

As to animal fat or tallow, the patentees proceed to describe the processes for the preparation of stearic acid from animal fat or tallow by crystallization. The animal fat or tallow is well cleansed from all impurities in the ordinary way; it is then, in a melted state, put into a round vessel, in which is a stirrer or agitator, and in which it is worked until it has cooled down to about 100 degrees of heat, when it will assume a milky appearance, with a granulated texture; the granulations are the stearine in a state of crystallization.

In this state it is put into the press, and subjected to a powerful pressure; the liquid which runs from the press is the elain or oil of tallow; the solid substance is the tallow stearine, for making candles when operated upon as follows:

Oxydation, or conversion of stearine into stearic acid. This process is exactly the same as is described for palm stearine. Separation of the stearic acid from the lime. This process is also the same as is described for palm stearic acid. Crystallization and pressing a second time; after the stearic acid has been well washed with hot water, it is again crystallized or granulated as before described, and pressed a second time. Refining process; the stearic acid is taken from the press, and refined by the second process described for refining palm stearic acid; after being well washed with pure hot water, it is filtered as described for palm stearic acid, and cast into blocks ready to make into candles. Thus has the substance become good stearic acid, which the patentee calls tallow stearic acid.

Another mode of carrying on the process with animal fat or tallow is as follows:—Having crystallized and pressed as before, the stearine obtained is to be saponified by combining it with the caustic leys of soda, potash, or any other alkali; thus making stearate of soda or potash, &c. This stearate of alkali is dissolved in a vessel with hot water and steam; to this must be added as much phosphoric acid as will neutralize the alkali and set the stearic acid free. The stearic acid is put into an evaporating vessel with a heat of 180 degrees, and is left until the whole of the water is evaporated; it is again pressed, and, after having been well washed and filtered, is cast into blocks, and ready to make into candles. The phosphate of the alkali, is decomposed with quick lime, forming phosphate of lime and caustic alkali; the caustic alkali is again employed to oxydize a fresh portion of stearine; the phosphate of lime is decomposed by sulphuric acid, and the phosphoric acid is ready to be again employed by this method; the only loss is the sulphuric acid and lime, being about 3 per cent. of the alkali and phosphoric acid.

As to common tallow, mix therewith margaric acid from palm oil, prepared and bleached as aforesaid, in the proportion of 10 to 20 lbs. of margaric acid to 100 lbs. of tallow in the manufacture of common mould, or dip candles.

As to bees-wax; we will lastly describe our method of operating upon this article, which is simply mixing with it a portion of our palm or tallow stearic acid in its highly improved state, in the proportions of from 5 to 10 parts of stearic acid to 100 parts of wax, and then proceeding to make candles of the materials so mixed, by running them into moulds in the ordinary manner of making other mould candles. Ibid.

## *Specification of a patent granted to* ALEXANDER *and* JAMES DIXON, *for their improvements in dyeing, by the application of materials not hitherto so used.* April 29, 1837.

This invention is comprised in a small compass. The patentees say, according to the ordinary processes of dyeing browns, greens, olives, Saxon blues, and blacks, a substance called "argal" (crude tartar) is employed as a mordant, as is well understood by dyers, which is an expensive material. Now, the object of this invention is to employ sulphate of soda as a mordant in the process of dyeing, in place of argal, by which the process of dyeing will be materially improved, both as to the cost and in other particulars.

The sulphate of soda is to be ground and sifted, in order to obtain it in the state of fine powder, similar to the condition in which argal is prepared for the dyer; and the subsequent treatment of sulphate of soda is similar to that pursued in preparing and employing argal as a mordant; and a dyer, acquainted with the ordinary process of using argal will, by substituting sulphate of soda, find the working of this invention easy to be performed; and he will find, that, in many respects, the colours will be produced more readily than when argal is used, and hence the time occupied in the dyeing with some colours be shortened.

It should be remarked, that the sulphate of soda obtained from the nitrate of soda, is that which is most generally effective for the various colours above mentioned; but the sulphate of soda obtained from common salt (muriate of soda,) though less valuable, as requiring more observation and care of the dyer, may be advantageously employed for a mordant in dyeing heavy colours, particularly browns and greens. Ibid.

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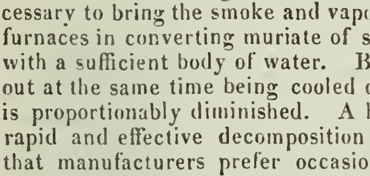
### *Specification of a patent for Improvements in the Manufacture of Carbonate of Soda; granted to* Francis Gybbon Spilsbury *and* William Maugham. *Sealed Jan.* 11*th, and enrolled July* 11, 1837.

This invention relates, first, to a method of condensing the muriatic acid gas, which is now suffered to escape into the atmosphere with the smoke and vapour of the furnaces.

Secondly, to a method of obtaining carbonate of soda from muriate of soda without first producing a sulphate of soda, whereby the expensive and laborious processes of obtaining and decomposing that sulphate are avoided. It is well known that in order to condense the muriatic acid gas (which escapes so largely in that part of the process of making carbonate of soda, which consists in converting muriate of soda into sulphate of soda,) it is only necessary to bring the smoke and vapours, which issue from the reverberatory furnaces in converting muriate of soda into sulphate of soda, into contact with a sufficient body of water. But the smoke cannot be so treated without at the same time being cooled down, whereby the draft to the furnace is proportionably diminished. A high temperature is so necessary to the rapid and effective decomposition of muriate of soda by sulphuric acid, that manufacturers prefer occasionally paying damages for the nuisance they occasion to the neighbourhood, rather than to submit to the positive and daily loss which must be the consequence of any check to the draught of their decomposing furnaces; it is therefore desirable to render the draught of the furnace independent of the higher or lower temperature of the column of air contained in the chimney, a mode of accomplishing which constitutes the first part of our invention.



*Description of the Drawing.*—A, E, represents a section of the principal flue into which all the flues of the several decomposing furnaces of alkali work unite. It is bent at right angles, rising, as shewn, from beneath the surface of the earth. B, is a steam-pipe proceeding from a steam-boiler delivering steam of from ten to twenty pounds on the inch pressure. The pipe, B, separates into three branches, C, C, C, terminated by jets of about one-quarter of an inch aperture each. D, D, is a partition of brick or other suitable material which divides the flue, A, E, transversely. In this partition are firmly embedded three pipes, F, F, F, not exceeding four inches diameter, and about eighteen inches long, open at both ends. These pipes form the only communication whereby the smoke can pass from the part of the flue, A, to that marked E. The jets of the steam-pipes C, C, C, are inserted, as shewn, into the centre of the parallel, and opposite, open pipes, F, F, F; they enter about two inches, the smoke passing around them freely in its passage through F, F, F, in the direction of the arrows. The effect of this arrangement is that so soon as steam of from ten to fifteen pounds on the inch is permitted to rush out of the jets, C, C, C, it communicates so great a velocity to the columns of air contained in the open pipes, F, F, F, that a most powerful draught is created in the flue, A, E, independent of any aid from the natural draught of the chimney. Although only three steam-jets and air-pipes are shown in the drawing, their number must be increased as the number of furnaces to be worked increases. The arrangement here described is sufficient for two large decomposing furnaces such as are ordinarily employed. Without exactly determining the number, which must depend upon circumstances peculiar to each manufactory, it may be generally stated, as a rule, that five air-pipes of four inch diameter, and five steam-jets of one-quarter of an inch aperture, projecting steam from ten to fifteen pounds pressure, will be found sufficient to work four large reverberatory furnaces more effectively than a chimney two hundred and fifty feet high. The end of the flue, E, is made to communicate with any form of condenser the manufacturer may choose, whereby the vapour and gas traversing the flue, may be brought into contact with a body of water sufficient to condense the aqueous vapour and absorb the acid, but as such condensation, and means for effecting the same, are well known, and as we do not claim any particular form, it is unnecessary to enter into a description thereof. After the smoke has been thus made to pass over the water, the uncondensable gases are to be carried into a chimney to escape in the ordinary way.

We will now describe our second improvement, which consists in a mode of producing carbonate of soda by converting muriate of soda into a fluoride of sodium or fluosilicate of soda (the latter is to be preferred as being the more insoluble,) instead of first obtaining a sulphate, as ordinarily performed in manufacturing carbonate of soda. For this purpose, concentrated fluoric acid, obtained from Derbyshire spar in any of the usual methods, and, as is well known, is to be mixed with its weight of muriate of soda, and so much water added as will prevent the muriatic acid from going off in the state of gas. There is then to be added sufficient ground flint, or other silicious matter, to convert the fluoride of sodium into fluosilicate of soda. The supernatant liquor, consisting of concentrated muriatic-acid holding a little fluosilicate of soda in solution, is then to be drained off. The remaining fluosilicate is then to be washed slightly with as little water as possible, after which it is to be transferred to a furnace, and subjected to a low red heat to drive off any adhering muriatic acid. The dry product is next to be mixed with double its weight of powdered chalk or limestone, and the whole boiled in water for several hours. The effect of this operation is a double decomposition, whereby the fluosilicate of soda and carbonate of lime are converted into fluosilicate of lime and carbonate and sesquicarbonate of soda, the latter being dissolved in the water. This supernatant liquor is to be drawn off, the residuum well washed, and the washings added to the first liquor, the whole is then to be evaporated to dryness, and the resulting product heated to redness. What remains is pure carbonate of soda, which may be redissolved in water and crystallized in the ordinary way. If instead of the fluosilicate of soda the fluoride of sodium is preferred, then the same process is to be gone through, with the omission of the ground flints, and the result will be fluoride of calcium and carbonate of soda.

Having thus described our invention, and the best means we are acquainted with for carrying the same into effect, we would remark in the first place as respects the condensation of the muriatic acid gas, we do not claim any form of condenser, or any peculiar method of bringing the gas and smoke from the decomposing furnaces into contact with water; neither do we confine ourselves to the exact arrangements, herein described. But we claim, as the first part of our invention, the application of a jet or jets of steam playing into the flue or flues of the ordinary decomposing furnaces employed by alkali makers, for the purpose of impelling the column of vapour and gases contained within them, independent of, or in conjunction with, the ordinary draught of the chimney, when performing that part of the process of making carbonate of soda which consists in converting muriate of soda into sulphate of soda.

Secondly, we claim the treating of muriate of soda with fluosilicic acid in the manufacture of carbonate of soda, in place of converting muriate of soda into sulphate of soda, and then into carbonate of soda, as heretofore practised.

Reper. of Pat. Inven.

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## *Specification of a patent for Smelting Iron with Anthracite Coal. Granted to* GEORGE CRANE. *Sealed Sept.* 28, 1836, *enrolled March* 28, 1837.

According to the ordinary practice of obtaining iron from iron-stone, mine, or ore, in this country, the iron-stone, mine, or ore, either calcined or in the raw state according to its respective qualities is put into suitable furnaces, with coke produced from bituminous coal, formerly called pit-coal in contradistinction to charcoal produced from wood, which was the fuel employed in this country previous to the introduction of pit-coal, in the smelting and manufacture of iron. Now as there are districts in which are to be found large quantities of iron-stone, mine, or ore, in the immediate neighbourhood of what is known as stone-coal, or anthracite coal, it has long been considered as a desirable object to employ such coal for the smelting and manufacture of iron, and although attempts have been made to apply such description of coal in the smelting and manufacture of iron, the same have failed and have been abandoned. In addition to such advantages to be obtained from the using of anthracite or stone coal in the districts where such coal is found together with iron stone, mine, ore, from the practice I have had, I am induced to believe such coal from its properties, will be found to produce a quality of iron more nearly resembling iron obtained by the aid of vegetable charcoal. Now the object of my invention, is the application of such anthracite or stone coal, combined with a hot-air blast, in the smelting or manufacture of iron from iron-stone, mine, or ore. And in order to give the best information in my power for enabling a workman to carry out my invention, I will describe the process, or means, pursued by me, and in doing so, I will suppose the furnace of an ordinary construction to be in blast, and that the machinery and apparatus are adapted for the application of hot-air blast, as is well understood and extensively applied in many places where the ordinary fuel (coke of bituminous coal, or the coal in a raw state) is employed in the manufacture of iron from iron stone, mine, or ore, and I have found that a furnace having suitable apparatus for heating the blast to about 600 degrees of Fahrenheit, a good arrangement for carrying out my invention, though so high a degree of temperature is not indispensably necessary, but I believe preferable. In charging such a furnace, I throw in about 300 weight of anthracite or stone coal or culm, to each 500 weight of calcined argillaceous iron stone, with a proper quantity of flux as if working with the coke of bituminous coal, such charging of the furnace and the general working, with the exception of the using of anthracite or stone coal, is to be pursued as if working with coke or bituminous coal, and I would remark that the quantities above given are such as I have hitherto employed in making the best qualities of pig-iron, videlicet, No. 1 or No. 2, at my works, from the anthracite, stone-coal, or culm, found in the neighbourhood of the Yniscedwyn Iron Works; but those quantities may be varied according to local circumstances, and the refractory nature of the iron-stone, mine, or ore, or otherwise to be reduced and the quality of iron desired to be obtained, as is the case in ordinary working, and at the judgment and discretion of the manager as heretofore. And I would remark that the anthracite or stone coal or culm, may be coked in like manner to bituminous coal before charging the furnace, but from my experience I have not (so far as my practice goes in working with the coal obtained in my neighbourhood) found that such coking is necessary, or that a more advantageous result is obtained than in applying the anthracite or stone-coal directly from the mine. And it is desirable to observe, I have found it of advantage that the blast of hot-air should be as free and unimpeded as possible, and from that account I have hitherto used only anthracite or stone coal, the smaller parts of which would not pass through a sieve of an inch mesh, but where the pillar or volume of blast is considerable, say two pounds and upwards on the square inch, this precaution is not necessary.

Having thus described the nature of my invention, and the manner of carrying the same into effect, I would have it understood that I do not claim the using of a hot-air blast separately, in the smelting and manufacture of iron as of my invention when uncombined with the application of anthracite or stone-coal and culm; nor do I claim the application of anthracite or stone-coal in the manufacture or smelting of iron, when uncombined with the using of hot-air blast. But what I do claim as my invention is the application of anthracite or stone-coal and culm, combined with the using of hot-air blast in the smelting and manufacture of iron, from iron-stone, mine, or ore, as above described.

Reper. Pat. Inventions.

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## Progress of Practical and Theoretical Mechanics and Chemistry.

### *Notice on the Bichromate of the Perchloride of Chrome.* By M. Walters.

I have constantly succeeded in the preparation of this compound by employing the quantities and process following: I placed in a tubulated glass retort 100 parts of sea-salt dissolved, and 168 parts of neutral chromate of potash, the whole being well mixed and reduced to a very fine powder; I then fixed to the retort a tube, and a receiver with two apertures, and poured by degrees, through a tube, in the form of an S, which was fixed in the aperture of the retort, 300 parts of concentrated sulphuric acid.

The liquor thus obtained is of a beautiful blood-red colour; it is volatile and sends forth vapour copiously; when placed in contact with a quantity of water, it falls to the bottom in drops of an oily appearance, and changes into chlorhydric acid and chromic acid; its boiling point is fixed and takes place at 118° Cent. under the pressure of $0^{m}\cdot76$; its specific gravity at the temperature of 21° Cent. is 1.71; it attacks mercury with great activity; for this reason all contact with this metal must be avoided; it is decomposed by sulphur, detonates with phosphorus, dissolves chlorine and iodine, and combines with ammonia with a disengagement of light. A small quantity mixed with concentrated alcohol combines with a violent explosion and the inflamed alcohol is scattered with force. This unexpected action very nearly deprived me of my sight, and has burnt me in a most dreadful manner.

The bichromate of the perchloride of chrome is composed according to my analyses, of

| | |
|---|---|
| Chlorine, | 45.14 |
| Chrome, | 35.58 |
| Oxygen, | 19.28 |

This result agrees with that obtained by H. Rose, and with a combination calculated according to the formula $2\ Cr\ O^3 + Cr\ O^6$.

$$Cr^3 = 1055.457 = 35.37$$
$$Ch^6 = 1327.950 = 44.51$$
$$O^6 = 600.000 = 20.12$$

The density of the vapour deduced from observation gives $D = 5.9$; the value obtained by calculation by means of the formula $2\ Cr\ O^3 + Cr\ Ch^6$, is equal to $D = 5.48$.

| | |
|---|---|
| 3 vol. of chrone | 11.6433 |
| 6 vol. of chlorine | 14.6760 |
| 6 vol. of oxygen | 6.6156 |

$$\frac{32{,}9349}{6} = 5.48$$

The analysis and the density of the vapour of the bichromate of the perchloride of chrome coincide therefore in representing this body as a combination of chromic acid and perchloride of chrome; its constitution may however be regarded in a different light, which, without being in contradiction either to the composition or to the density found, explains, in a certain degree better its remarkable characters and its little stability. Dr. Thomson having subjected this body at the time to analysis, had already offered quite a peculiar opinion on its constitution; he regarded it as being formed of chromic acid and of chlorine, and called it *chloro-chromic* acid; but this opinion could not withstand the objection of H. Rose, that with this supposition the combination must contain 10 per cent. more chlorine than obtained by analysis. But if instead of representing this combination as formed of chromic acid and chlorine, we look upon it as being formed of $Cr\ O^2$ and chlorine, the hypothetical radical $Cr\ O^2$ of chromic acid (itself expressed by the formula $Cr\ O^2 + O$,) acting the part of a simple body similar to the oxide of carbon and to benzoyl, this combination becomes analogous to the chloro-oxicarbonic acid, the chlorine occupying the place of the oxygen, which is not found in the radical of chromic acid. We may therefore represent this body by the formula $Cr\ O^2 + Ch$, which agrees both with analysis and with the density found. Indeed the analysis calculated according to this formula gives the following result:

| | | |
|---|---|---|
| 1 atom of chrome | 351.819 = | 35.37 |
| 2 atoms of chlorine | 442.650 = | 44.51 |
| 2 atoms of oxygen | 200.000 = | 20.12 |
| | 994.469 | 100.00 |

And as to what concerns the density, calculated according to the same formula, we find

| | |
|---|---|
| 1 vol. of chrome | 3.8811 |
| 2 vol. of chlorine | 4.2890 |
| 2 vol. of oxygen | 2.2078 |
| | 10.9809 |

$$\frac{10.9809}{2} = 5.49$$

But here each atom of the compound represents only two volumes of vapour. This body may therefore be regarded as a distinct acid, which might be named *chloro-oxi-chromic acid.* Recollecting that the perchloride of chrome does not exist in an isolated state, that analogous compounds are only produced by acids, which for one atom of radical, contain three atoms of oxygen, which are isomorphous with each other, and which may all be expressed after the hypothesis of M. Persoz, by the formula $R\,O^2 + O$, in taking into consideration the facility with which this body is decomposed when brought into contact with other bodies, and its little stability; this manner of regarding the constitution of this body, which explains its various actions, offers the appearance of much probability.

Lond. and Edin. Philos. Mag.

### *Preparation of Bicarbonate of Potash. By* Prof. Wœhler.

Carbonate of potash, both in the dry state and in solution, combines very slowly with the second equivalent of carbonic acid to form the bicarbonate of potash. By means of charcoal in a finely divided state the combination may be made to take place very easily. It can be performed in the following manner: bitartrate of potash is to be heated in a covered crucible, the burnt mass to be moistened with water, put into a receiver, and carbonic acid passed through it. The absorption takes place with such rapidity that the mass becomes strongly heated, so much so that it is necessary to surround the receiver with cold water to prevent the reconversion of it into carbonate of potash. The saturation is complete when it ceases to give out heat. It is then dissolved in the smallest possible quantity of water at the temperature of 100° to 120° Fahr.; upon the cooling of the filtered solution, the greater part of the bicarbonate separates in fine crystals.—*Poggendorff's Annals.*

Lond. & Ed. Philos. Mag.

### *Preparation of Protoxide of Tin.*

Owing to the great difficulty of preparing protoxide of tin according to the directions generally given in chemical works, I was led to make some experiments on the subject. I find the following process to be that which yields the purest oxide. Prepare a solution of protochloride of tin by dissolving the metal in hydrochloric acid, taking care always to have a great excess of the metal; the solution is then evaporated to dryness, together with a lump of tin to prevent the formation of perchloride. The tin is then separated, and the chloride weighed, and rubbed in a mortar with its equivalent, or rather more, of crystallized carbonate of soda; the mixture soon becomes fluid; it is then put into an evaporating dish and heated on the sand-bath, frequently stirring, till it becomes thoroughly black; it is then removed and well washed with boiling water, filtered, and dried at a gentle heat on the sand-bath. The oxide thus prepared is of a beautiful blue-black or slate-colour; it is very soluble in hydrochloric acid, and when heated to dull redness in the air, it takes fire and burns, and is converted into peroxide.

S. A. Sandall.

*St. Thomas' Hospital, January 3rd,* 1838.

Ibid.

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### *Efficacy of Lightning Rods, or Conductors. By* F. Maceroni.

I perceive that a question is mooted at the meeting of the British Association for the Advancement of Science, whether in the case of a certain "monument 140 feet high, erected on the summit of a mountain 1,400 feet high, augmented safety, or danger, would be the consequence of attaching to it a conductor or paratonnere?" I am induced to call the attention of your intellectual readers to this passage, as I am very sure that the subject is of great importance to society. About six months ago (vol. xxvi. p. 367) you honoured me by giving insertion to my account of a safety gunpowder magazine, in which I speak of lightning conductors, and to which I would request your readers to refer. There is just now a gentleman, one Lieutenant Green, of the Royal Navy, who is endeavouring to convince the public by his writing, that conductors are prone to cause the damage they are intended to avert. I must say, that I regard this statement as a mischief, for I have seen too much of the saving power of conductors not to wish that every house in Great Britain were protected by one.

Lieutenant Green, in his anti-paratonnere pamphlet, lately published by Tanner, of New Bond street, tells us of fifty churches in this country having been lately struck by lightning, because they had metal vanes! To be sure;—but metal vanes are not conductors; and conductors should not be formed of a wire scarcely bigger than a bell wire. In my above quoted article, I have stated, that a tube is better for a conductor than a solid rod, because it is to the surface of bodies that electricity adheres. Nothing could be fitter for the purpose than iron gas pipes; but their connexions and attachments, down the building, must be of stone, or other non-conducting materials.

Previously to the church of St. Peter's, at Rome, being protected by numerous conductors, by the French government, damage was continually being done to the upper part of that stupendous edifice; but never was the least injury inflicted after the application.

It must be borne in mind, that an elevated and efficient conductor will give its protection more frequently in perfect silence, and unobserved, than by conducting into the ground, or water, a positive discharge of electric matter, accompanied by a flash and thunder. The many-pointed conductors will silently draw off the electricity from a passing cloud, without any discharge. properly so called, so that the blow has been parried, if it be not a *bull* to say so, before it is struck.

During my several sojourns at Rome, I have made particular inquiries into the effects of lightning on St. Peter's church. After the numerous substantial, many-pointed conductors were affixed to the summit, and most prominent angles, of the church, by the French in 1808, an electric discharge was not known to have fallen upon it more than three times, and then it did no injury. It appears that the clouds, in passing over the church, are deprived of their plus electricity by the conductors, just as a Leyden jar is silently equilibrized by the presentation of a metallic, pointed conductor. How many ships would be saved from damage, conflagration, and, perhaps, instant submersion, by properly constructed vehicles for conveying the electric fluid over the sides into the water? What inconvenience could be felt, from a branched rod and a chain from the mast-head, hanging along the shrouds into the water! All the failures of conductors arise from their want of sufficient mass of metal. A zinc chain, or tube, would be far less liable to oxidation than iron; and, as I have before remarked in the case of a powder magazine, &c., the metal might easily be kept with a clear surface, by an occasional rubbing with a brick-bat. About London we see conductors not thicker than a quill, applied to shot towers, tall chimnies, &c., whereas they ought to be gas tubes of at least an inch in diameter. The top ought to be formed in the manner of a branch of a tree, with five or six points of copper gilt, the extreme points being of pure gold or silver, as are those at Rome.

In some volcanic districts, over which it would appear that the solidified crust of our globe, which covers the yet incandescent mass, is thinner or more porous, than at other points, the electrical exchange of compliments between the earth and atmosphere, are almost as frequently directed upwards from the earth to the clouds, as in the contrary direction. Even against such upward discharges, the conductors, inserted in the earth, and ascending to the summit of the building, will preserve them from injury. I have witnessed a great many instances of ascending streams of electricity, some of which I have remarked upon in your pages, particularly in Nos. 401 and 402; and I am induced to think that we should see many more exhibitions of the process, were it not for the trees which act as silent conductors, both upwards and downwards. Electricity is the real food of plants, which they absorb through the innumerable points of their leaves and branches. On the same principle should a lightning-conductor be constructed with as many points as convenient.

Lieutenant Green says, "seventy-nine churches in Great Britain have in a few years been struck; some of them destroyed; many, after being furnished with from one to four conductors. All of those struck had metal vanes." How "many," out of the seventy-nine churches, were furnished with conductors, this opponent to Benjamin Franklin, does not tell us. He only shows the danger of metal vanes inviting the lightning, without a conductor to take it away. A bit of wire attached to the walls by iron eye bolts, or staples, is certainly more likely to cause mischief than to give protection. A proper and elevated conductor will generally carry off the electricity silently, without any apparent discharge.*

Lond. Mech. Mag.

### *New Experiment on Galvanic or Chemical action.*

The following experiment is communicated to "The Annals of Electricity, Magnetism and Chemistry, conducted by William Sturgeon," by a correspondent whose signature is L. B. W.

"I took a smooth and clean piece of zinc, about the size of a walnut, inserted it in a piece of bullock's gut, and having carefully squeezed out all the air from the gut, tied it tight at both ends. I then placed the zinc, so surrounded by the gut, (into which there could be no mechanical possibility of entrance to the fluid,) into a jar of dilute sulphuric acid, and left it so all night. In the morning I found the gut full of gas almost to bursting. To prove the nature of the gas I made a pin hole in the membrane, and, squeezing the gas through the flame of a candle, found, as I expected, that it was hydrogen.*

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* *Note.* The above article is inserted because the fact stated respecting St. Peter's Church is deemed important; it otherwise assumes as facts what requires to be verified. *Ed.*

Here there could have been no voltaic influence; for zinc *alone* can produce none. Chemical it could only have been by the transmission of the acid; but the gut contained none. The zinc bore the same clean appearance as when first inserted, and was nowise oxidated.

"I repeated the experiment again and again, with the same result, excepting only that I found the inside of the bladder, or gut, and the zinc slightly moistened with a tasteless vapid fluid." L. B. W.

To W. Sturgeon, Esq.
&c. &c. &c.

The interesting facts above stated, appear to admit of satisfactory explanation from experiments made by the Editor of the Journal, and published in the first number of his Annals. He ascertained that different points on the surface of the same piece of metal are evidently in different states of electric polarity, and act towards each other, where connected by imperfect conductors, like the poles of a voltaic battery, producing a decomposition of the interposed fluids. There can be little doubt, therefore, that the moisture supplied by the gut was decomposed by the voltaic action of the zinc itself, the oxygen of the moisture combining with the metal, while the hydrogen escaped and expanded the enclosing membrane.

G.

## Progress of Civil Engineering.

### *Asphaltic Mastic.*

The ancients were indebted for the preservation of their buildings to the choice of their materials, and particularly to the use of cements, which, perfectly uniting with metal, stone, or wood, rendered their structures firm and solid. Amongst others, the use of a bituminous cement appears to have been extensive from the earliest times. Historians inform us, and modern observation confirms their statements, that the bricks with which the walls of Babylon were constructed were cemented together with hot bitumen. And in the destruction of some ancient remains of fortifications, supposed to have been Roman, near Pyrimont, about forty years ago, the stones appear to have been similarly cemented; and so great was their tenacity, that the works were with great difficulty pulled down, and not without the use of gunpowder. This circumstance led to a singular and important discovery, for the fact of which, as follows, we are indebted to a gentleman named Perrigny, a native of that neighbourhood. During the removal of the above ancient remains, it was observed that the cement bore a great resemblance to the asphaltic mass or mountain in the park of Pyrimont, about five miles north of Seyssel. This led several persons present to think of making a similar application of it; amongst others was a relative of M. Perrigny, whose dwelling on the banks of the Rhone was so very damp, that the lower part could not be appropriated to any use whatever. This person considered that its application might succeed in keeping out the wet, every other remedy that he had tried having failed. The experiment was, accordingly, made, and succeeded beyond his most sanguine expectations. This circumstance, among other early trials of its properties, speedily led to its very general adoption in that vicinity, where the working of this material has become of great importance, and where the presence of the bituminous asphalte is so great as to appear almost inexhaustible, and, although but recently worked to any great extent, yet its properties as a cement appear to have been long known. It already constitutes the chief wealth of the country, which was previously half wild.

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*That animal membrane (bladder gut) has not only a permeability to fluid, but a power, by capillary attraction, of raising it two or three feet above its level, I call to witness my friend Goldworthy Gurney, who lately related to me the following experiment. Fill a glass funnel with water, and tie a fresh bladder over the large opening so securely that no water can escape; place it, with the bladder downwards, in a vessel (large dish) also full of water. Into the nozzle, or small end, of the funnel, a tube of 3 feet in length is to be inserted and secured quite tight by luting; set the apparatus thus arranged aside, and watching it, it will be found, said my informer, that the water will soon begin to rise in the tube, and ultimately reach the height of two or three feet.

In various parts of the eastern chain of the Jura mountains, there are bituminous veins of greater or less extent; but the only place at present known where the asphaltic rock is to be found is at Pyrimont, above named in the department de l'Ain. In this immediate vicinity is also obtained a peculiar kind of mineral pitch, there called bitumen, which, upon being mixed in certain proportions with the asphalte, forms the mastic, or cement, of which it is our business to treat, and which, in France, after years of struggling with prejudices, and the opposition of parties interested in its failure, is obtaining so large a share of patronage as to be extensively employed both in the public and private works of that kingdom.

For many years after the discovery of the valuable properties of the asphalte, the mine at Pyrimont was the property of a company of Swiss merchants; but, from their defects of management, and from the limited extent of their finances, their operations were confined within very narrow bounds; and, at length languishing, the properties of the mastic were likely to have become lost to society. It, however, passed into other hands, among whom we find the English name of Taylor, and also of Mr. Equem, a gentleman who has persevered against all opposition in calling the attention of the French engineers and architects to the subject; and having executed a variety of works with unvaried success, has secured for it a rapidly advancing popularity in France, where we have lately had an opportunity of professionally examining and acquainting ourselves, not only with its nature, but also with its manipulation.

The business has now fallen into the hands of a private company at Paris, who, with a capital of 30,000*l.*; purchased the mine at Pyrimont, and are carrying on an extensive trade in its manufacture, with Mr. Equem at the head of the executive department.

The asphaltic mastic of Seyssel, when prepared for use, is, as before observed, a compound of two mineral substances; one is the native asphlate, the other is bitumen; the proportion of the former in the amalgum is 93 centimes, and of the latter 7 centimes. The asphlate is extracted from the mine in blocks, and reduced to an almost impalpable powder before it is mixed with the bitumen. The latter, as extracted from the mine, is first broken into pieces of about the size of an egg, these are put into boiling water, and the particles which rise to the surface are purified by boiling for 24 hours: the result is, the bitumen to be mixed with the pulverised asphlate. The combination of these two substances forms the mastic or cement, which being reduced to a fluid state by the application of caloric, is poured into moulds of any shape required; or, in this state, used as cement in hydraulic works, &c. The use of the bitumen appears to be the giving of ductility to the mastic; and, if a very minute quantity of sulphur be added, the mastic will become hard, and partially brittle.

In France, where, with the exception, we believe, of Belgium, this mastic has, at present, only been employed, attempts have been made to imitate it; but in these fictitious compounds substances have been introduced, instead of asphalte, which absorb from 40 to 50 per cent of bitumen, forming a composition which the heat of the sun will melt, and which cracks when exposed to the cold of winter. In other instances, matter has been substituted which, having no affinity whatever for bitumen, disintegrates with time. When in Paris, we had an opportunity of making a fair comparison between the genuine and the fictitious materials. In the abattoir of Montmartre, one of the great public slaughter-houses of Paris, a part has been laid down with the mastic of asphalte, and another part with the fictitious mastic, both as substitutes for flag-stone pavement. For this purpose, perhaps a more severe test of their respective merits could not have been found, being exposed to the tramping of men and cattle, the dying struggles of the latter, with the blood and water with which it is constantly deluged. The flag-stone pavement hitherto used required frequent repairs and renewal; yet so great are the tenacity and hardness of the genuine mastic, that, although it had been thus in use for many months, it appeared as if it was new; whilst, on the other hand, the fictitious mastic had worn so much in holes as very much to resemble a honeycomb; and these holes being filled with blood and filth, presented to an unaccustomed eye a very disagreeable sight.

The genuine mastic possesses the hardness of stone, and yet preserves a certain elasticity. When used as pavement for terraces or footpaths, it appears to resist the wear equally well with granite; and, when prepared in the manner now adopted in Paris, it is difficult to distinguish it in such situations from that stone. One of the finest specimens of paving that ever came under our notice, and which, at first sight, we mistook for granite, is that on the north side of the palace and gardens of the Tuilleries: it is about 1100 yards in length, and 10 ft. wide; it is composed of the asphaltic mastic; and the joints, which transversely cross it the whole breadth, and which at present appear to divide the pavement into a number of large, equally sized slabs, are disappearing, by the mastic becoming more dense from the tramping of feet; so that this extensive piece of pavement will soon appear, from end to end, like one immense sheet of stone.

A few minutes after the mastic has been spread in a fluid state, it again takes its natural density, which is such, that, at the heat of 30° Reaumur (equal to 100° of Fahrenheit,) it resists all impressions from an ordinary force. Its extensive application to the covering of buildings, instead of tiles, slate, or lead, has induced the trial of experiments in France, by which it was ascertained that it is anti-electric, a property which it is desirable that all bodies should possess that are employed in roofing.

Its application, also, for the flooring of halls, passages, and apartments is no way dangerous on account of fire, as it is not inflammable, the quantity of pitch which it contains being so very small. For the floors of underground kitchens, &c., it is particularly applicable, it being warm, and keeping out all damp, as well as vermin and insects, which are frequently so abundant in such places. When employed in the construction of water tanks or reservoirs, it imparts neither taste, smell nor colour, to the water it contains. Arch. Mag.

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## *On the Valuation of the Mechanical Effect of Gradients on a Line of Railroads.* By PETER BARLOW, ESQ., F. R. S.

The exact amount of the influence of ascents and descents occurring in the line of railway, on the motion of a load drawn by a locomotive engine, having been differently estimated by different persons, the author was induced to investigate the subject. A few observations are premised on the erroneous assumptions which, he conceives, have in general vitiated the results hitherto deduced. The first of these is that the expenditure of power requisite for motion is equal to the resistance to inaction; whereas, it must always greatly exceed it. No account, he remarks, has been taken of the pressure of the atmosphere on the piston, which the force of the steam has to overcome before it can be available as a moving power. Another source of error has been that the statical and the dynamical effects of friction have been confounded together; whereas, they are the same in amount, only when the body is put in motion by gravity, but not when it is urged down an inclined plane by an extraneous force. In the latter case, these effects are no longer comparable; friction being a force which, in an infinitely small time, is proportional to the velocity, while that of gravity is constant at all velocities; or, in other words, the retardation from friction is proportional to the space described, while that from gravity has reference only to the time of acting, whatever space the body may pass over in that time. It is an error, to assume that the mechanical power of the plane is equivalent to a reduction of so much friction; for the friction down the inclined plane is the same as on a horizontal plane of the same length, rejecting the trifling difference of pressure; and the whole retardation in passing over the plane, or the whole force required to overcome it, is the same at all velocities, and by whatever force the motion is produced; but the assisting force from gravity is quite independent of the space, or of the velocity.

In the investigations which the author has presented in this paper, he assumes that equal quantities of steam are produced in the same time at all velocities; and he adopts for his other data, those given by Mr. Pambour in his Treatise of Locomotive Engines; he deduces a formula from which, the speed on a level being given, we may compute the relative and absolute times of a train ascending a plane; and consequently, also, the ratio of the forces expended in the two cases: or the length of an equivalent horizontal plane; that is, of one which will require the same time and power to be passed over by the locomotive engines as the ascending plane.

The next objects of enquiry relate to the descent of trains on an inclined plane, and comprise two cases; the first, that when the power of the engine is continued without abatement, and the second, that when the steam is wholly excluded, and the train is urged in its descent by gravity alone. The author arrives at the conclusion, that in the first of these cases, when the declivity is one in 139, the velocity, on becoming uniform, will be double that in a horizontal plane; and that for a declivity of one in 695, the uniform velocity of descent will be one-fifth greater than on the horizontal plane; and this he observes, is perhaps the greatest additional velocity which it would be prudent to admit. A plane of one in 695 is therefore the steepest declivity that ought to be descended with the steam-valve fully open; all planes with a declivity between this and that of one in 139, require to have the admission of steam regulated so as to modify the speed, and adjust it to considerations of safety; and lastly, all planes of a greater slope than this last, require, in descending them, the application of the brake. Lond. Mech. Mag.

## *Defacing Public Buildings and other Objects.*

In France and Italy, so strong is the admiration for public gardens, for statuary, and other works of art, that they may be exposed to the public for years together, without getting in the slightest degree defaced or destroyed; whereas in Great Britain every public edifice, monument, or iron railing, is more or less injured. If a gentleman, in the neighbourhood of a town give the public the privilege of walking through his grounds, he may expect to find the borders trod upon, and flowers plucked up, perhaps by the root, his trees cut or torn down, and every thing more or less destroyed. In one of the public gardens in a town on the Continent, a nightingale built its nest and hatched its young inside a bush, within reach of the public walk. A footman, servant to an English family resident there, observing the nest, seized it and carried it off. So strong was the indignation of the populace, who caught the offender in the act, that he was brought before a magistrate, and condemned to be drummed out of the city, with a label on his breast, intimating his crime; which was executed amid the hootings of the populace. Whatever virtues the people of Great Britain possess, they have yet to learn the practical principle, "Look at every thing, and touch nothing." We know of nothing that will operate as a cure, so powerfully as the establishment of schools for infant and juvenile training; and we appeal to facts in proof of this position.—*Stow's Training System.* Arch. Mag.

## *Railway Speculators.*

Some extraordinary evidence was given, it is said, before one of the Parliamentary committees, as to the means used to obtain the amount of subscriptions required by the standing orders of the House of Commons. A Jew, whose name bore a resemblance to that of a great capitalist, signed his name for 25,000*l.* This individual had neither house nor lodging: he received 4*l.* for signing the deed. Persons were employed to procure signatures, who received 5*s.* for each, giving four to the signer, and keeping one for themselves. The names of the clerks were put down for 500 shares each. One man's name appears for 32,000*l.*, and another for 20,000*l.* A news-agent signed for 10,000*l.*, and his son for 3000*l.*, and one of the solicitors for 1000 shares. One of the secretaries to the company procured signatures to the extent of 215,000*l.*; another to the extent of 86,000*l.*; and a third to the amount of 260,000*l.* Several of the directors, whose names stood for 10,000*l.* each, caused the figures to be altered to 20,000*l.*, on the day before the deed was sent to be deposited in the proper office.—*Observ.*

Min. Jour.

### *Important improvement in Beams for Building.*

A beam of very extensive dimensions, without pillar or prop, has been erected at the Pottery Gas Works, across the whole span of the new retort house, which is fifty feet. There are few objects, perhaps, connected with mechanism more worthy of inspection as a matter of curiosity, or a proof of the stupendous power of mechanical skill and contrivance. Hitherto the plan for erecting beams has been without recourse to the aid of mechanism, but in this beam there is brought to a practical result the whole power and ability that the materials are capable of, at a great saving of expense. The whole is fire-proof, supporting an iron roof of twenty tons, whilst the beam itself weighs only two tons. It is made upon Witty and Co.'s patent principle. We are informed that two such beams as this would be quite sufficient to support a bridge of fifty feet span. We have often thought that a very great saving might be made in bridge building by something of this kind, whereby objects which usually cost thousands might be accomplished for as many hundreds. We would recommend this invention strongly to the notice of railway companies; for it appears to exhibit the very thing wanting in viaducts for railways, and would cost but a tithe of the expense of those massive structures. No proof can be more convincing as to its practicability and application to viaducts than this beam and roof.—*North Staffordshire Mercury.*

Farm. Mag.

## Progress of Physical Science.

### *On the Cause, the Prevention, and the Cure of Cataract. By* SIR DAVID BREWSTER.

Having submitted to the Physical Section of the British Association an account of a singular change of structure produced by the action of distilled water upon the crystalline lens after death, Sir D. Brewster was desirous of communicating to the Medical Section some views which this, and previous observations, have led him to entertain respecting the cause, the prevention, and the cure of cataract, he makes the following observations.

The change of structure to which I have referred consists in the development of a negative polarizing band or ring between the two positive rings nearest the centre of the lens; the gradual encroachment of this new structure upon the original polarizing structure of the lens; and the final bursting of the lens after it had swelled to almost a globular form by the absorption of distilled water.

As the crystalline lens floats in its capsule, there can be no doubt that it is nourished by the absorption of the water and albumen of the aqueous humour, and that its healthy condition must depend on the relative proportion of these ingredients. When the water is in excess, the lens will grow soft, and may even burst by its over absorption; and when the supply of water is too scanty, the lens will, as it were, dry and indurate; the fibres and laminæ, formerly in optical contact, will separate, and the light being reflected at their surfaces, the lens will necessarily exhibit that white opacity which constitutes the common cataract.

This defect in the healthy secretion of the aqueous humour, as well as the disposition of the lens to soften or to indurate by the excess or defect of water, may occur at any period of life, and may arise from the general state of health of the patient; but it is most likely to occur between the ages of 40 and 60, when the lens is known to experience that change in its condition which requires the use of spectacles. At this period the eye requires to be carefully watched, and to be used with great caution; and if any symptoms appear of a separation of the fibres or laminæ, those means should be adopted which, by improving the general health, are most likely to restore the aqueous humour to its usual state. Nothing is more easy than to determine at any time the sound state of the crystalline lens; and by the examination of a small luminous image placed at a distance, and the interposition of minute apertures and minute opake bodies of a spherical form, it is easy to ascertain the exact point of the crystalline where the fibres and laminæ have begun to separate, and to observe, from day to day, whether the disease is gaining ground, or disappearing.

In so far as I know, cataract in its early stages, when it may be stopped or cured, has never been studied by medical men; and even when it is discovered, and exhibits itself in white opacity, the oculist does not attempt to reunite the separating fibres, but waits with patience till the lens is ready to be couched or extracted.

Considering cataract, therefore, as a disease which arises from the unhealthy secretion of the aqueous humour, I have no hesitation in saying that it may be resisted in its early stages, and in proof of this I may adduce the case of my own eye, in which the disease had made considerable progress. One evening I happened to fix my eye on a very bright light, and was surprised to see round the flame a series of brightly coloured prismatic images, arranged symmetrically, and in reference to the septa to which the fibres of the lens are related. This phenomenon alarmed me greatly, as I had observed the very same images in looking through the lenses of animals partially indurated, and in which the fibres had begun to separate. These images became more distinct from day to day, and lines of white light, of an irregular triangular form, afterwards made their appearance. By stopping out the bad parts of the lens, by interposing a small opake body sufficient to prevent the light from falling upon it, the vision became perfect, and by placing an aperture of the same size in the same position, so as to make the light fall only on the diseased part of the lens, the vision entirely failed.

Being now quite aware of the nature and locality of the disease, though no opacity had taken place so as to appear externally, I paid the greatest attention to diet and regimen, and abstained from reading at night, and all exposure of the eyes to fatigue, or strong lights. These precautions did not at first produce any decided change in the optical appearances occasioned by the disease; but in about eight months from its commencement I saw the coloured images and the luminous streaks disappear in a moment, indicating, in the most unequivocal manner, that the vacant space between the fibres or laminæ had been filled up with a fluid substance transmitted through the capsule from the aqueous humour. These changes took place at that period of life when the eye undergoes that change of condition which requires the use of glasses, and I have no doubt that the incipient separation of the laminæ would have terminated in confirmed cataract had it not been observed in time, and its progress arrested by the means already mentioned. Since that time, the eye, though exposed to the hardest work, has preserved its strength, and is now as serviceable as it had ever been.

If the cataract had made greater progress, and resisted the simple treatment which was employed, I should not have hesitated to puncture the cornea, in the expectation of changing the condition of the aqueous humour by its evacuation, or even of injecting distilled water, or an albuminous solution, into the aqueous cavity.

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### *On Electrical Induction. By* Michael Farraday, Esq., D. C. L., F. R. S., &c.

The object of this paper is to establish two general principles relating to the theory of electricity, which appear to be of great importance; first, that induction is in all cases the result of the actions of contiguous particles; and secondly, that different insulators have different inductive capacities.

The class of phenomena usually arranged under the head of *induction* are reducible to a general fact, the existence of which we may recognise in all electrical phenomena whatsoever; and they involve the operation of a principle having all the characters of a first, essential and fundamental law. The discovery which he had already made of the law by which electrolytes refuse to yield their elements to a current when in the solid state, though they give them forth freely when liquid, suggested to the author the extension of analogous explanations with regard to inductive action, and the possible reduction of many dissimilar phenomena to one single comprehensive law. As the whole effect upon the electrolyte appeared to be an action of the particles when thrown into a peculiar polarized state, he was led to suspect that common induction itself is in all cases an *action of contiguous particles*, and that electrical action at a distance, which is what is meant by the term induction, never occurs except through the intermediate agency of intervening matter. He considered that a test of the correctness of his views might be obtained by tracing the course of inductive action; for if it were found to be exerted in curved lines it would naturally indicate the action of contiguous particles, and would scarcely be compatible with action at a distance. Moreover, if induction be an action of contiguous particles, and likewise the first step in electrolyzation,* there seemed reason to expect some particular relation of this action to the different kinds of matter through which it was exerted; that is, something equivalent to a specific electric induction for different bodies; and the existence of such specific powers would be an irrefragable proof of the dependence of induction on the intervening particles. The failure of all attempts to produce an absolute charge of electricity of one species alone, independent of the other, first impressed on the author the conviction that induction is the result of actions among the individual and contiguous particles of matter, having both forces developed to an extent exactly equal in each particle.

The author describes various experiments, with the view of showing that no case ever occurs in which an absolute charge of one species of electricity can be given. His first experiments were conducted on a very large scale: an insulated cube, twelve feet on the side, consisting of a wooden frame, with wire net-work, every part of which was brought into good metallic contact by bands of tin foil, had a glass tube, containing a wire in connexion with a large electrical machine, passed through its side, so that about four feet of the tube entered within the cube and two feet remained without; but it was found impossible, in any way, within this apparatus, to charge the air with the least portion of either electricity.

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* Chemical decomposition by the electric current,—G.

For investigating the question whether induction is an action of contiguous particles, and for deciding that of specific inductive capacity, the author employed, in conjunction with the torsion balance of Coulomb with certain variations and additions (such as an electrometer,) a new apparatus, constructed for the express purpose. This apparatus consisted of two hollow brass spheres, of very unequal diameters, the smaller placed within the larger, and concentric with it; the interval between the two being the space through which the induction was to be effected. The apparatus had a tube in the lower part, furnished with a stop-cock, by means of which it might be connected with an air-pump, or filled with any required gas. In place of the lower hemispherical shell of air, occupying the interval between the two spheres, any solid dielectric, of the same form, such as shell-lac, glass, or sulphur, might be substituted. Two of these instruments, precisely similar in every respect, were constructed, and the author ascertained that the inductive power was the same in both, by alternately charging each, and dividing the charge with the other, and finding that, in all cases, the charge remaining in the one, and also that received by the other, was very nearly half the original charge.

The experiments on which the author principally relies, in support of the correctness of his views relative to induction being exerted in curved lines, are the following: a brass ball being laid on the top of an excited cylinder of shell-lac placed perpendicularly, the charge which a carrier ball received when brought to different points near to the brass sphere, was measured by means of the electrometer, and it was inferred, from the characters of the electricity, that the charge was one by induction, and, from its measure, that it proceeded in curved lines. By substituting for the brass sphere a disc of metal, above the shell-lac cylinder, it was found that when the carrier ball was brought near to the middle of the disc no charge was communicated, although a sensible one was obtained at the edge of the disc, and also at a point above its centre, further removed from the excited cylinder. Corresponding, and very striking, results were obtained when a brass hemisphere was placed on the top of the cylinder of lac. The charge communicated at the centre of the hemisphere was only one third of that obtained at the edge of its periphery; but by taking it at a point at some height above the centre, and consequently much further removed from the inducing cause, the charge was nearly equal to that of the periphery. Here, the author remarks, the induction fairly turned a corner, exhibiting both the curved lines or courses of its action, when disturbed from their rectilineal form by the shape, position and condition of the metallic hemisphere, and also a lateral tension, so to speak, of these lines on one another; all depending on induction being an action of the contiguous particles of the dielectric thrown into a state of polarity and tension, and mutually related by their forces in all directions. In the foregoing experiments the dielectric was air, but they were afterwards varied by substituting a fluid, as oil of turpentine, and likewise a few solid dielectrics, namely, shell-lac, sulphur, carbonate and borate of lead, flint-glass, and spermaceti; and with these, corresponding results were obtained. These results, the author considers, cannot but be admitted as arguments against the received theory of induction, and in favour of that which he has put forth.

In the course of these experimental researches, some effects due to conduction, which had not been anticipated, and which were similar to the residual charge in the Leyden jar, had been obtained with such bodies as glass, lac, sulphur, &c. If the inductive apparatus, fitted with a hemispherical cup of shell-lac, after having remained charged for fifteen or twenty minutes, was suddenly and perfectly discharged, and then left to itself, it would gradually recover a very sensible charge; the electricity which thus returned from an apparently latent to a sensible state, being always of the same kind as that given by the charge. This return charge is attributed to an actual penetration, by conduction of the charge, to some distance within the dielectric at each of its two surfaces, and several experiments are adduced in support of this view. With shell-lac and spermaceti the return charge was considerable; with glass and sulphur, it was much less; but with air, no decided effect of the kind could be obtained. As this was an effect which might interfere with the results, in the method the author adopted for deciding the question of specific inductive capacity, and as time was requisite for this penetration of the charge, its influence on these results was guarded against, by allowing, between the successive operations, as little time as possible for this peculiar action to arise.

The author thus states the question of specific inductive capacity which he had proposed to investigate:—I suppose A an electrified plate of metal suspended in the air, and B and C two exactly similar plates, placed parallel to, and on each side of, A, at equal distances, and un-insulated; A will then induce equally towards B and C. If in this position of the plates, some other dielectric than air, as shell-lac, be introduced between A and C, will the induction between them remain the same? or will the relation of C and B to A be altered by the difference of the dielectrics interposed between them?

The experiments of Coulomb, from which it appeared that a wire surrounded by shell-lac took exactly the same quantity of electricity from a charged body, as the same body took in air, seemed to the author to be no proof of the truth of the assumption, that, under such variation of the circumstances as he had supposed, no change would occur. Entertaining these doubts of the conclusions deducible from Coulomb's result, he had the apparatus previously described constructed, as being well adapted for this investigation. After rejecting glass, resin, wax, naphtha, oil of turpentine, and other substances, as unfit for the purpose in view, he chose shell-lac as the substance best calculated to serve as an experimental test of the question.

For the purpose of comparing the inductive capacities of shell-lac and air, a hemispherical cup of shell-lac was introduced into the lower hemisphere of one of the inductive instruments, so as to nearly fill the lower half of the space between the two spheres; and their charges were divided in the manner already described; each apparatus being used in turn to receive the first charge, before its division with the other. As the two instruments were known to have equal inductive powers when air was contained in both, any deficiencies resulting from the introduction of the shell-lac would show a peculiar action in it, and if unequivocally referable to a specific inductive influence, would establish the point in question.

The air apparatus being charged, and its disposable charge being 290°, this charge was divided between the two. After the division the charge in the lac apparatus was 113°, and in the air apparatus 114°. From this it appears, that whilst, by the division, the induction through the air lost 176°, that through lac gained only 113°. Assuming that this difference depends entirely on the greater facility possessed by shell-lac of allowing or causing inductive action through its substance than that possessed by air, then the capacity for electric induction would be inversely as the respective loss and gain; and assuming the capacity of the air apparatus as unity, that of the shell-lac apparatus would be $\frac{176}{113}$ or 1.55.

When the shell-lac apparatus was first charged, and then the charge divided with the air apparatus, it appeared that the lac apparatus, in communicating a charge of 118°, only lost a charge of 86°. This result gives 1.37 as the capacity of the lac apparatus.

Both these results, the author considers, require a correction; the former being in excess, the latter in defect. Applying this correction, they become 1.50 and 1.47. From a mean of these and several similar experiments, it is inferred that the inductive capacity of the apparatus having the hemisphere of lac is to that with air as 1.50 to 1.

As the lac only occupied one half of the apparatus containing it, the other half being filled with air, it would follow from the foregoing result, that the inductive capacity of shell-lac is to that of air as 2 to 1.

From all these experiments and from the constancy of their results the author deems the conclusion irresistable, that shell-lac does exhibit a case of *specific inductive capacity.*

Similar experiments with flint-glass gave its capacity 1.76 times that of air. Using in like manner a hemisphere of sulphur, it appeared that the inductive capacity of that substance was rather above 2.24 times that of air, and the author considers this result with sulphur as one of the most unexceptionable.

With liquids, as oil of turpentine and naphtha, although the results are not inconsistent with the belief that these liquids have a greater specific inductive capacity than air, yet the author does not consider the proofs as perfectly conclusive.

A most interesting class of substances, in relation to specific inductive capacity, the gases or aeriform bodies, next came under the author's review.

With atmospheric air, and likewise with pure oxygen, change of density was found to occasion no change in the inductive capacity. Nor was any change produced, either by an increase of temperature or by a variation in the hygrometric state.

The details are then given of a very elaborate series of experiments with atmospheric air, oxygen, hydrogen, nitrogen, muriatic acid, carbonic acid, sulphurous acid, sulphuretted hydrogen, and other gases, undertaken with the view of comparing one with another under a great variety of modifications.

In conclusion, the author remarks, "Thus induction appears to be essentially an action of contiguous particles, through the intermediation of which the electric force originating or appearing at a certain place, is propagated to or sustained at a distance, appearing there as a force of the same kind and exactly equal in amount, but opposite in its direction and tendencies. Induction requires no sensible thickness in the conductors which may be used to limit its extent, for an uninsulated leaf of gold may be made very highly positive on one surface, and as highly negative on the other, while the induction continues without the least interference of the two states. But with regard to dielectrics, or insulating media, the results are very different; for their thickness has an immediate and important influence on the degree of induction. As to their quality, though all gases and vapours are alike, whatever be their state, amongst solid bodies, and between them and gases, there are differences which prove the existence of specific inductive capacities."

The author also refers to a transverse force with which the direct inductive force is accompanied. The experimental proof of the existence of such a force, in all cases of induction, is, from its bearing on the phenomena of electro-magnetism and magneto-electricity, of the highest importance, and we cannot but look forward with the greatest interest to the promised communication in which these and other phenomena relating to this subject will be reviewed. Lon. & Ed. Philos. Mag.

## *Effect of Cultivation upon Climate.*

The question of the tendency of cultivation, and more especially the clearing of forests, upon the temperature of countries, has been much discussed, but without those definite results, which a subject of so much interest naturally claims. Until meteorological statistics shall be more diligently and accurately preserved, which there is reason to believe will be the consequence of an increasingly enlightened and expanding system of legislation, this question will not be solved with the desired precision. No country in the world, is more favourable to its accurate solution than our own. In one respect, the means are at hand of throwing much light on this subject,—namely—whether, within the observation of the settlers of our new countries, there has been any diminution or increase of the level of the water of lakes and ponds, and the quantity which flows in rivers which can be ascribed only to the effect of clearing and cultivation.

In a memoir on this subject by M. Baussingault, a translation of which appears in Jameson's Edinburgh Journal, Jan. 1838, facts are detailed from which the author draws the following conclusions:—

1st. "That the extensive clearing of a country diminishes the quantity of running water which flows over its surface; 2dly, that it is impossible for us to determine, at present, whether this diminution is owing to a smaller annual quantity of rain, or to an increased evaporation of the surface-water; or to those two causes combined; 3dly, that the quantity of running water does not appear to have varied in countries which have not been subjected to any changes arising from the progress of cultivation; 4thly, that, independent of the preservation of surface water, forests husband and regulate their flow; 5thly, that cultivation, when established in an arid country, which is not covered with forests, dissipates a portion of its running streams; 6thly, that, in clearings which are purely local, springs may disappear, without there being any ground to conclude that the annual quantity of rain has diminished; and 7thly, that drawing our conclusions from the meteorological facts collected in equinoxial regions, we may presume that the extensive clearing of a country diminishes the annual quantity of rain which falls upon it."

M. Baussingault enjoyed extensive opportunities of observations in South America as well as in Europe. No traveller since the time of Humboldt, has turned to a better account such opportunities in connexion with the resources of science. He cites the following, among other cases.

"Oviedo,* who, towards the end of the fifteenth century, so often traversed the valley of Aragua, positively affirms that New Valencia was founded in 1555, at the distance of half a league from the lake of Tacarigua; and M. de Humboldt found, in the year 1800, that the town was more than three miles (2700 toises) distant from its banks. The aspect of the district exhibits additional evidence of a great change. The rising grounds, which are somewhat elevated above the plain, maintain to the present day the name of islands, which at a former period, was most accurately assigned to them, seeing they were surrounded with water. The space which has been exposed by the retreat of the waters has been transformed into most fertile fields for the cultivation of cotton, sugar-cane, and the banana tree. These buildings which were reared in the immediate vicinity of the water are seen to be more and more forsaken by it. New islands made their appearance in the year 1796. An important military post in the shape of a fortress, which was built in 1740 in the island of *Cabrera*, is now situated on a peninsula. Lastly, in two islands of granite, those, namely, of Cura and of Cabo-Blanco, M. de Humboldt discovered, among the bramble bushes, several yards above the level of the water, deposits of fine sand, containing many *helicites*. Facts which are so speaking as these, and withal so well ascertained, could scarcely fail of exciting the ingenuity of the learned on the spot, in the way of supplying explanations of the remarkable change; and they all agreed thus far, that some subterranean conduit had been opened up, which allowed the waters to flow freely to the ocean. M. de Humboldt, when on the spot, paid all due regard to this supposition, and after an accurate examination of the localities, came very decidedly to the conclusion, that the cause of the diminution of the waters of the lake of Tacarigua was nothing more than the extensive clearing away of the woods, over the whole valley, during the course of the former half century. "In laying low the trees," he observes, "which covered the tops and flanks of the mountains, mankind, in all climates, are, at one and the same time, entailing two great calamities upon succeeding generations; they are producing a scarcity both of wood and water."

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*His Historia de la Provincia de Venezula, was published in 1823.

Since the time of Oviedo, who, like all the older chronologists, is perfectly silent concerning any subsidence of the water of the lake, the cultivation of indigo, sugar, cotton, and cocoa, had been carried to a great extent. In the year 1800 the valley of Aragua maintained a population as dense as that of any of the most populous portions of France. The smiling prosperity which existed in the numerous villages which teemed with its industrious population, could not be witnessed without the greatest satisfaction. Such was the prosperous condition of this charming country when M. de Humboldt was sojourning in La Hacienda de Cura.

After a lapse of twenty-two years, it was my lot afresh to visit the valley of Aragua. I fixed my residence in the small town of Maracay. I soon found that, for many years, the inhabitants had been remarking not only that the waters of the lake had ceased to subside, but, on the other hand, they affirmed they were very decidedly rising. The lands which had been formerly occupied in the cultivation of cotton were now submerged. The islands of Las Nuevas Aparecidas, which had risen above water in the year 1796, had now become shallows, which were dangerous for navigation. The tongue of land near to Cabrera, at the northern side of the valley, was now so narrow, that the smallest rise in the lake altogether inundated it; and a steady breeze from the northwest was sufficient to submerge the road which led from Maracay to Nueva Valencia.

The fears, which for so long a time had annoyed the inhabitants on its banks, were now altogether changed in their character; and they no longer dreaded the entire disappearance of the lake. They were now anxiously considering if these successive invasions of the rising waters were about to overwhelm their properties; and those who had explained the previous diminution, by the existence of subterranean canals were convinced that they were now choked up, and that nothing would save them but opening the conduits afresh.

During the two-and-twenty years which had intervened, important political transactions had occurred. Venezuela now no longer belonged to Spain. The smiling valley of Aragua had been the arena of the most bloody contests, and war and death had desolated those happy scenes, and greatly reduced the population. On the first cry of independence, a number of slaves obtained their liberty by fighting under the standard of the new republic. Its wide spreading cultivation was neglected; the forest trees, so luxuriant within the tropics, had again in a great measure usurped dominion over that region, which its inhabitants, after a century of constant and painful labour, had reclaimed. During the growing prosperity of the valley of Aragua, the numerous streams which fed the lake had been arrested and employed in innumerable irrigations, and their beds were found dry for more than six months of the year. At the last epoch to which I have alluded, the streams being no longer so diverted flowed without interruption. Thus, then, during the progress and continuance of agricultural industry in the valley of Aragua, when the process of clearing was pushed farther and farther, and when cultivation in every shape was advancing, the level of the water gradually subsided. More lately, on the contrary, during a period of misfortune, and, we would fain hope, but temporary, when the clearing was no longer continued, and the cultivated lands have fallen back into their wild state, the waters having ceased to fall, and are now very speedily assuming a decided rising movement.

I shall now direct my remarks to another quarter, without however leaving America, in which we find a climate analogous to that of Europe, and where we traverse immense districts producing the most valuable grains. I shall direct attention to the higher lands of New Grenada, and to those elevated valleys, from 6000 to 9000 feet above the level of the sea, which enjoy, throughout the year, a temperature of from 58° to 62° Fahr. Lakes are frequent among the Cordilleras; I might easily dwell upon many of these, but shall bring under review only those which have been the subject of previous observations.

The village of Ubata is placed in the vicinity of two lakes. It is an important fact that, sixty years ago, these two sheets of water formed one only. The older inhabitants have observed the waters gradually diminish, and their shores extend themselves year after year. Fields of corn, of the greatest fertility, at the present time cover districts which thirty years ago were completely covered with water. The falling of the mean level of this lake will the more readily be credited by the consideration, that an occasional fall of three or four inches lays bare a great extent of surface. If we inquire in the neighbourhood of Ubata of any of the old men, who in their younger days were devoted to the chase, or if we examine the records of any of the different parishes, no doubt will remain that numerous forests have been felled. The clearing still goes on; and it is equally certain that the retreat of the water has not ceased, though it does not advance so rapidly as it was wont to do.

It is hoped that such of the readers of the Journal of the Institute, as may have the means of obtaining correct information on a question of this nature, in the interior and particularly in the more elevated regions of the United States, will not neglect the opportunities they enjoy, and that the facts which they obtain, may be given to the public in that, or some other, Journal, so as to serve the purpose of accumulating evidence in relation to the meteorology of our country. G.

## *Meteorological Observations.*

Although the hope was expressed in the Journal of the Institute, that all those Societies, Academies and Colleges which are provided with the instruments necessary in a series of meteorological observations, would advert to the interesting and important proposition of Sir John Herschel, of collecting the results of simultaneous observations from all parts of the world. (see Journ. Frankl. Inst. for Sept. last, p. 190, et seq.) and that they will be willing to use a little exertion, to comply with so reasonable and judicious a request, I have not yet had the pleasure of knowing that such observations were made during the late equinox, at any place in this vicinity, or State*. There may not have been time yet for the reception of any of the registers made in conformity to these suggestions; but it is hoped that they will be forthcoming. As an evidence of the interest which men of the highest rank in science (and it would be difficult to name one which stands higher than the proposer himself,) take in the progress of meteorology, I extract a portion of a lecture given by Professor Airy, (the present Astronomer Royal) at Neath on the 9th of September last, while on a tour in Wales. It was delivered by request, at the opening of the Scientific Institution in that town, and is replete with the most sensible remarks on the objects and duties which may most profitably engage the attention of such an Institution. G.

"Among the subjects of scientific observation to which the attention of persons in this neighbourhood may be called, is the general department of meteorology. Though much has been done in regard to observation, yet so little has been made out to place it in the rank of a science, properly so called (by the establishment of rules of any kind deduced from past phenomena, and which may be expected to hold in future ones) that I have great difficulty in pointing out any distinct course in which the efforts of persons willing to pursue this subject may be most advantageously directed. But there can be little doubt that regular observations of the barometer, thermometer, dew-point, actinometer, anemometer, electrometer, and rain-guage, would contribute to the establishment of empirical laws regarding the succession of phenomena at this place; and that the institution of observations simultaneous with those at other places would assist in determining the relations of the weather at different places depending on their respective localities, or the progress of a state of weather from one place to another. With reference to this matter, I would most strenuously recommend (even if all others be omitted) the making of observations at every hour during a day and a half at each of the solstices and equinoxes, in conformity with the plan sanctioned by Sir John Herschel. As to the classifications of, and deductions from, meteorological observations, I have no general rule to give, except that such classification be always made with reference to some preconceived theory or rule of some kind. If it does not appear that any irregularity follows, steadily, the conceived rule, some new one must be sought: but if an irregularity depending on this rule be detected, it will be best to subtract from every observation the corresponding amount of this irregularity, and then to examine the remainders with the view of discovering new laws of irregularity. For instance, if it should be found that, upon combining all the barometrical observations made at the same hours of different days, there was upon the whole a certain irregularity depending on the hour of the day, this might be subtracted from the observed heights, and the heights thus connected might be treated as if they had been so observed: if then, upon combining all at the same seasons of different years, an irregularity should be found, depending on the time of year, this might be subtracted: in like manner, if irregularities could be found depending on the moon's age, the moon's declination, the moon's distance from perigee, &c., these might be successively subtracted: and if after all these deductions there should be found a distinct relation between the height of the barometer and the state of the wind on the same day, or the day before, or the day after, a great step would have been made. But I mention these points merely as instances of the way in which I think it will be absolutely necessary to proceed.

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* The only Register, in conformity to this plan, which I have noticed in the American Journals, is that contained in the Mathematical Journal, of the Flushing Institute, Long Island.

"A class of observations, implying small expense and no great trouble, is the observation of the direction of the magnetic needle at intervals of five minutes throughout certain days, in conformity with the plan recommended by Gauss and Humboldt, and now acted on from the west of continental Europe to the east of Asia. It is known to you that the direction of the needle varies from year to year, from day to day, and from morning to afternoon; but it has also been found that it is subject to incessant irregularities from one minute to the next. In particular it has been remarked, that, when an Aurora Borealis was visible at one place, very great disturbances of the needle have been noticed at many other widely separated places in which the Aurora could not be seen. From the concurrence of the observations, as far as they have yet proceeded, this conclusion has been deduced: that the irregularities at very distant parts of the earth are strictly simultaneous in time, depending apparently not upon the time of day, or any other circumstance which distinguishes one place from another, but arising from some unknown causes which Humboldt aptly terms 'magnetic storms.' But are these storms universal? The observations of Glamorganshire may assist to determine this point.* And if so, what are they? Do they influence the weather, the state of health, or any other circumstance immediately affecting our bodily comforts? I know nothing which impresses the imagination more strongly than to find that we are surrounded by an agent, which, in the shape of magnetism is almost unperceived, but in the state of galvanism or lightning may be most powerful; and to know that even in its weakest state it is the part of a great system whose arbitrary laws are felt, with certainty and regularity, in its most distant region. It is like finding ourselves under the quiet espionage of a mighty government, whose motives of action we know not, but whose universality of power we feel most sensibly.

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* A variation needle has, since the delivery of this address, been mounted at Neath.

"For giving the due efficiency to the various labours of the members of the Institution, it will at some time be necessary to publish Transactions. Let it not be supposed that the Transactions of local societies are of small value, or unrespected in the world. The memoirs of the Manchester society may be cited as among the most valuable collections of local information and general science which we possess. The expense of such works in a cheap form, need not to be very great. Min. Rev.

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## *On the increase of Temperature in the interior of the Earth.*

M. Arago has lately communicated to the Academy of Sciences the result ofthe thermometrical observations which he made, on the first of May last, in the well which is now being sunk at the slaughter-house (Abattoir) of Grenelle. The boring has now reached the depth of 1312 English feet. The bed of chalk, in which they have for so long been engaged, is not yet traversed, but the numerous flints, which were unceasingly met with at lesser depths, have now disappeared. The city of Paris has determined that the boring shall continue to the depth of 2295 English feet, if the spouting water be not found sooner. It is presumed that the water which will issue from so great a depth will possess a temperature of between 93°2 and 95° Fahr., and, in that case, it might be employed for hot baths, &c. But however this may be, we shall now adduce the thermometrical observations which have been made at the depth of 1312 English feet. On the 29th of April, at 7 P. M., four instruments were sent down, viz. two of M. Bunten's self registering thermometers, one a *diversement* thermometer which M. Magus of Berlin had recently sent to M. Dulong, and another of the same construction manufactured by M Walferdin. The two first were contained in a copper tube, in which they were secure from the pressure of the water; the third was open at the top, but in such a manner that the pressure could not alter its form; and the fourth was enclosed in a glass tube, which was hermetically sealed. These four instruments. after having remained for about thirty-six hours in the well or bore, were removed from it on the first of May about 7 A. M.; they then indicated the following temperatures:—

| | |
|---|---|
| The first thermometrographe of M. Buten, | 74°.3 |
| The second, do. | 74°.21 |
| M. Magus' thermometer, á diversement, | 74°.30 |
| M. Walferdin's do. | 74°.66 |

Assuming, then, 74°.3 Fahr. as the temperature at the depth of 1312 English feet, if you subtract from this number that of 51°.08 Fahr., which indicates the mean temperature of the surface of the earth at Paris, 23°.22 will remain for the increase of temperature, corresponding to 1312 English feet of depth, or, what comes to the same thing, 1°.8 Fah. for 101.2 English feet. If we take the case of the observatory as the starting point for the temperature where it is at 53°.06 Fah., 21°.24 Fah. will then be given as the augmentation for 1222.5 English feet which corresponds to 103.348 English feet for each centigrade degree.

## Mechanics' Register.

### *Russian Gold Mines.—Important Discovery.*

The St. Petersburgh letters are much occupied with a discovery relative to the working of the Russian gold mines, which, if truly stated, may come to have some influence on the circulation of the precious metals. A letter of the 26th ult., says, "There has been found out, it is said, in the Ural Mountains, a new mode of extracting gold from the earth, sand, or ore. The sand, or earth, has been put into a blast furnace and melted, and the most extraordinary results obtained. By washing, the method hitherto pursued in Russia, one and a half zolotnicks of gold were produced, from 100 poods of sand, &c. the expenses were about covered; two zolotnicks per 100 poods were worth working. Fine sand, or earth, rarely produced more than three zolotnicks, and five zolotnicks were quite uncommon. By the new process, on 100 poods of melted sand, they obtained sixty zolotnicks in some cases; in others, forty to fifty zelotnicks, and on melting 100 poods of previously washed sand, they got forty to fifty zolotnicks, of gold. There is little doubt of the accuracy of these statements, but what the comparative expense of the two modes is I cannot tell you, nor whether the Ural grows sufficient wood for fuel, and whether coal can be found there. One pound Russian contains ninety-six zolotnicks; 100 poods are about 3.550lb. English weight."

The Editor of the Mining Journals adds:

The importance to be attached to the new process. by smelting, of extracting gold from the ores, or deposits, in the Ural Mountains, is so considerable, from the increased quantity obtained, as will be observed by reference to a paragraph, extracted from the columns of a contemporary, and inserted in our present number, that we are induced to direct the particular attention of our readers to the subject, while it will be our province to endeavor to obtain more detailed information of the plan adopted. The vast outlay of capital in Brazil, where attention has been directed to the gold districts, and the numerous veins which are found in Virginia and in the neighbourhood of Charlotte, in the United States, renders the subject one deserving of the first consideration. The process of smelting, as applied to gold ores, is not novel in theory, although we believe the present to be the first instance of its successful practical adaptation; and, if we are to credit the statement that the produce has been raised from five to fifty, or ten times the amount obtained, merely by the introduction of an improved mode of reduction, while the halvans, or refuse, have been found to contain a large produce, it is an epoch in mining, which will tend much to revive the spirits of the shareholders in the "Union Gold Mining Company," and others of a similar nature, and proves that this peculiar department of mining is in its infancy. We expressed our opinion at the time of the announced failure of the success of the "Union Gold Mines," that an improved mode, or one perfect in itself, so far as improvements then had taken place, would doubtless have yielded profitable returns, and we sincerely trust, that the present discovery will be found applicable to the ores of America, which, however, are, if we mistake not, of a different character to those of the Russian possessions.

We have here, then, an additional evidence of the affinity and importance of science being combined with practice—of the association and the advantages derived from the application of chemistry to the operation of the miner; and hence further proof of the advantages which may be fairly calculated upon from the establishment of a "School of Mines."

### *New process for Extracting Gold.*

To the Editor of the Mining Journal.

Sir:—The following information respecting the extraction of gold in the Russian dominions, I have lately received from an intelligent and well-instructed officer of mines in the Emperor's service, and as you are properly anxious to be informed on the subject, I send it to you:—

"Knowing very well the deep interest you take in all scientific discoveries, especially in the mining and metallurgical departments, I thought it might be agreeable to you to be informed of a new discovery made in the Uralian Mountains, in the method of extracting gold from the alluvial deposits. In the official letter received in Paris, I learned that the following curious comparative experiments were made in the extracting of the gold from the sand, by Mr. Anossott:—

1. "By the common method of washing used in all countries having gold (stream-work.)

1. "By the amalgamation—the method similar to that employed in Hungary in gold mines.

2. "By the damp way, or dissolving the sand in acids.

4. "By melting the sand in the blast furnaces.

"Those experiments were made by the order of the Minister of Finance, Comte Kancrin, to the end of ascertaining the exact quantity of gold contained in a given quantity of sand, and extracting the gold from the very middle of the grains.

"By the second method; they obtained eight times more gold than by the first (common system.)

"The third method produced four times more gold than the first; but by the fourth method, that is to say, by melting the sand, twenty-four times more gold was obtained than by the washing system.

"In that process, the produce of the melting is an alloy of cast iron and gold (fonte aurifere,) from which the gold is separated by means of sulphuric acid. By putting this last method into practice, we shall obtain yearly 8000 poods (sixty-two poods equal to one ton) of gold instead of 400, from the same quantity of alluvial deposit. But the conservatory principle, applied to the national wealth of the Government adopts the plan of only a moderate increase of the annual produce of gold, and securing thus a longer existence to the alluvial deposits."

The statement as to the difference produced by the modes of treatment may appear startling at first, but it may be considered as more probable if we take into account the nature of the substance in which the gold is enveloped. The produce of smelting, we see, is an alloy of cast-iron and gold, indicating that, as is very usual, the substance accompanying this gold is iron. Now, to say nothing of the very imperfect results which can be obtained by the old method of washing, if we consider the ingenious application of amalgamation which is mentioned, we shall at once perceive, that every particle of gold which is wrapt up in iron must infallibly escape the action of the mercury, and it is not difficult to imagine, that a very considerable proportion may be so defended. Let the whole, however be reduced by fusion, and all the metallic part will then be brought together and separated at once from the earthy part, and consequently, little or none of the gold can escape. Thus, we may account for a very considerable difference in the results of the processes that have been employed. The separation of the gold from the iron by sulphuric acid, is not likely to produce any waste of the precious metal.

It is anticipated, I know, that this improvement may be extended to other gold-producing countries, and I have no doubt but it may in due time; but it should be recollected, that smelting is a very expensive and tedious process in some of these countries, partly from scarcity of fuel, and partly from very imperfect methods for producing the necessary blast, by which it happens that the degree of heat required is difficult to obtain. Improvements may be made so as to remedy some of these defects, and one important one, I believe, would be, the application of the hot air blast; but those who know what the difficulties are in making alterations in established processes in some of the countries to which these observations are applicable, will see that considerable time may be required to accomplish the object, and the selection of very judicious and well instructed agents to carry the necessary measures into operation.

To any one who may be considering the subject with a view to adopting the use of this discovery, I would also suggest, that the chemical separation of the metals, is an operation which must be directed by one possessed of considerable skill and experience, and that it can only be done where sulphuric acid, or substances not easily transported, can be supplied in sufficient quantities. If the alloy be rich enough to bear the charge of carriage it might be better to send it to places where the requisite skill and materials can be had with facility, but here again, the fiscal regulations of different countries may oppose an obstacle.

I merely throw out these hints that persons who may wish to avail themselves of the advantages held out by this process, may be prepared to meet the difficulties that present themselves, and to set about the undertaking in a manner most likely to ensure success.

I am, Sir, your obedient servant,

*Chatham place, July* 6. JOHN TAYLOR.

## *Smith's Ever-pointed Stone-Cutting Chisel.*

The ordinary chisels used for dressing and cutting stone very frequently want sharpening, which is an operation requiring time, judgment, and expense; having, when blunted, to be forged and sharpened, and afterwards hardened and tempered. A machine maker of the name of Smith in this town has lately invented an ever-pointed chisel, which will I think soon be generally adopted, provided it be made cheap. It is in fact an application of the principle upon which Messrs. Mordan's (or rather Mr. Hawkins') ever-pointed pencil is constructed. A thin plate of well tempered steel, of the width of the chisel required, is placed between two cheeks of iron, and held tightly between them by means which I shall describe. The point of the thin steel projecting beyond the ends of the iron cheeks, forms the cutting edge of the chisel; and as soon as the edge which projects is worn away by the friction of the planing stone, the steel is advanced between the cheeks, and the edge is thus immediately renewed. To prevent the steel plate from slipping side-ways, there are studs on each side of it, on one of the iron cheeks, which go into corresponding holes in the other cheek. The whole is held together by a collar or mortise slipping over, and hammered up tightly, the cheeks being of a wedge shape. When the mortise, or collar, is driven properly home, a groove therein coincides with a groove in the cheek of the chisel, and a wedge being put into the hole thus formed, holds the whole chisel tight, and prevents the mortise from being shaken off by the blows of the mallet.

At the top of each cheek, on the inside, is the half worm of a screw; between these, a screw is inserted, the end of which touches the top of the steel plate, and on being turned down with a screw-driver, or otherwise, forces the steel out from between the cheeks for renewing the working edge.

I hope I have described the thing clearly enough to be understood by my brother masons and your readers, without the aid of a drawing; my hands are too rough and stiff with handling the mallet and chisel, and moving our hard native stone, to attempt the draughtsman.

I am, Sir, yours respectfully,

A STONEMASON.

Bradford, Yorkshire, Nov. 28, 1837. Mech. Mag.

## *British Enterprise Abroad.*

The traces of British capital are to be met with everywhere abroad. Most of the cities of Europe which enjoy the "new light" of the nineteenth century are furnished with it by "The British Continental Gas-Association," and Paris itself is about to be supplied with water on the English plan, by a Company of which the shares are in a great measure held by Englishmen. A "Sardinian Mining Company" has recently been established, for the purpose of working a number of mines in the Savoy, which are said to be exceedingly rich, and to offer very peculiar advantages. The proprietors are English, and they propose to smelt the ore by a new English process. The whole of the mines, of silver, copper, and iron, in the Duchy of Nassau, have been leased to an English association, who expect to reap important advantages from the application of a greater degree of skill and capital to the works than has ever hitherto been bestowed upon them. It is said that the total number of mines in the possession of this Company is upwards of two hundred and eighty! Ibid.

### *Manufactures of Lancashire.*

Probably the largest entire room for manufacture in this county, and if so, in Europe, is that of Messrs. T. and E. Grundy, at Heap Bridge, near Bury. It is appropriated to the manufacture of wollens, and is 85 yards in length by 75 in width, and 12 feet in height; is supported by 253 pillars, some of which also bear gearing; it has 65 large windows, and 253 skylights; 672 feet of steam piping run through it; about 2,688 feet of shafting are at work. It contains, or will contain, eight carding engines, probably the largest in this county; eight gigantic slubbing frames; 40 mules; 200 looms, some for weaving prials, three in width; 450 gas jets; will be worked by one engine of comparatively small power, and is surmounted by a funnel of 69 yards and two feet.—*Bolton Free Press.*

Mech. Mag.

### *Flint in Wheat.*

The scoundrels who burn wheatstacks in the country leave behind them some curious chemical results. "Swing" is a grand experimentalist. There are found in the embers lumps of coarse glass, which are the result of the fusion of the silicia, or flint, which wheat straw in particular is found to contain in very considerably quantities.

Min. Jour.

### *Iron.*

The quantity of iron made in this country during the year 1836, has been estimated at the enormous quantity of a millon tons; the average price of pig-iron for the year being about 7*l.* per ton, and that of bar-iron about 11*l.* per ton.

Ibid.

| LUNAR OCCULTATIONS FOR PHILADELPHIA, AUGUST 1838. | | | | | Angles reckoned to the right or westward round the circle, as seen in an inverting telescope. ☞ For direct vision add 180° ☜ | |
|---|---|---|---|---|---|---|
| Day. | H'r. | Min. | Star's name. | Mag. | from Moon's North point. | from Moon's Vertex. |
| 3 | 9 | 3 | Im. p Sagittarii | ,6, | 137° | 119° |
| 3 | 10 | 7 | Em. | | 241 | 235 |
| 14 | 13 | 37 | N. App. ☽ & C Tauri 4, 5, ☽ North 3′, 9 | | | |
| 24 | 1 | 10 | Im. α Virginis, | ,1, | 51 | 25 |
| 24 | 2 | 32 | Em. | | 227 | 220 |

The meteorological table for this number, not having been received from our correspondent, the publication of it is necessarily postponed until the next number.

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